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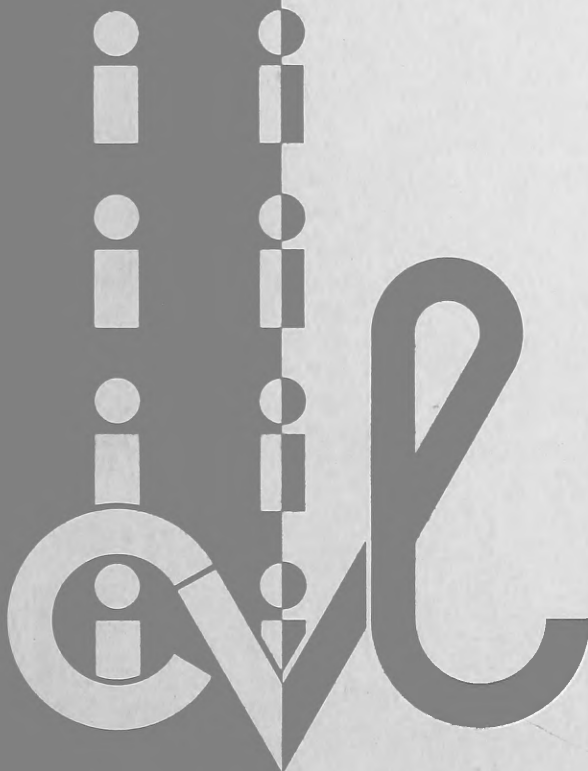


# JOINT HIGHWAY RESEARCH PROJECT


JHRP-76-16

FINLIN USER'S MANUAL

M. B. Roy



PURDUE UNIVERSITY  
INDIANA STATE HIGHWAY COMMISSION



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User's Manual

FINLIN USER'S MANUAL

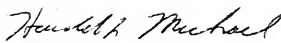
TO: J. F. McLaughlin, Director                      May 5, 1976  
Joint Highway Research Project

FROM: H. L. Michael, Associate Director              Project: C-36-62F  
Joint Highway Research Project                      File: 9-8-6

The attached "FINLIN User's Manual" is provided for the computer program FINLIN developed in the HPR Part II Research Study "Performance of Pipe Culverts Buried in Soil". Its development and formulation is reported in the Interim Report "Predicting Performance of Pipe Culverts Buried in Soil", M. B. Roy, JHRP-76-15, May 1976.

This Report and its companion volume, JHRP-76-15, were presented to the JHRP Board at its meeting on May 5, 1976, and accepted as fulfillment of the objectives of Phase I of the Study. It is now forwarded for review, comment and similar acceptance by ISHC and FHWA.

Respectfully submitted,



Harold L. Michael  
Associate Director

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1. Report No. JHRP-76-16		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle FINLIN USER'S MANUAL				5. Report Date May 1976	
				6. Performing Organization Code	
7. Author(s) M. B. Roy				8. Performing Organization Report No. JHRP-76-16	
9. Performing Organization Name and Address Joint Highway Research Project Civil Engineering Building Purdue University W. Lafayette, Indiana 47907				10. Work Unit No.	
				11. Contract or Grant No. HPR-1(12) Part II	
12. Sponsoring Agency Name and Address Indiana State Highway Commission State Office Building 100 North Senate Avenue Indianapolis, Indiana 46204				13. Type of Report and Period Covered User's Manual Computer Program FINLIN	
				14. Sponsoring Agency Code	
15. Supplementary Notes Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration. From the study, "Performance of Pipe Culverts Buried in Soil".					
16. Abstract  This is a User's Manual for the Computer Program FINLIN (Finite element, Isoparametric, <u>Non-Linear</u> with <u>Interaction</u> and <u>No-tension</u> ). It is a finite element computer program for analysis of flexible pipe culverts buried in soil. Details of mathematical formulations, developments of different element properties, and related information can be found in the Interim Report "Predicting Performance of Pipe Culverts Buried in Soil", M. B. Roy, JHRP-76-15, May 1976.					
17. Key Words Pipe Culverts; Design of Pipe Culverts; Finite Element Analysis; Pipe Culverts in Soil				18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 77	
				22. Price	



User's Manual  
FINLIN USER'S MANUAL

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Project No.: C-36-62F

File No.: 9-8-6

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project  
Engineering Experiment Station  
Purdue University

in cooperation with the

Indiana State Highway Commission

and the

U. S. Department of Transportation  
Federal Highway Administration

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

This User's Manual is for the computer program for analysis of flexible pipe culverts buried in soils and reported in Interim Report "Predicting Performance of Pipe Culverts Buried in Soil", M. B. Roy, JHRP No. 15, May 1976.

Purdue University  
West Lafayette, Indiana  
May 5, 1976





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## CHAPTER I. INTRODUCTION

FINLIN (Finite element, Isoparametric, Non-Linear with Interaction and No-tension) is a finite element computer program for analysis of flexible pipe culverts buried in soil. Curved bar segments have been used to simulate flexible pipes. A zero thickness special type of frictional element is used to simulate the occurrence of slip between pipe and soil. Isoparametric, linear-strain triangular elements are used to represent the soil. Non-linear, anisotropic, state of stress-dependent soil properties expressed in terms of octahedral stresses are used. Several option commands permit realistic analysis of a culvert problem in two dimensions. Incremental stages of construction, controlled slip between soil and pipe and no-tension analysis can be performed. The program has been written in FORTRAN IV source language using hard and soft wire facilities available in the CDC computer system. In this report, the procedure for preparation of input data for a problem will be discussed; a complete listing of the source program is included. Details of mathematical formulations, developments of different element properties, and related information can be found in the Interim Report - "Predicting Performance of Pipe Culverts Buried in Soil", by M. B. Roy, Purdue University, May, 1976, JHRP-76-15.

In any finite element analysis the first step is to bound the problem by a set of finite boundaries with appropriate boundary conditions. Then each region of different materials has to be distinguished. In the next step, each zone is subdivided into a number of characteristic finite elements maintaining continuity at the boundary between two elements. Then nodes and elements are numbered in sequence. Required material properties for every element need to be defined. In the case of nonlinear analysis, where material properties change depending upon the state of stress, parameters which govern the variation of properties need to be defined. Also, construction in layers, load application in increments, limited shear or slip in the pipe-soil inter-



action, and no-tension in soil must be accommodated.

Preparation of data for a real problem should take advantage of the fact that:

1. The boundaries need only define the areas of primary interest, and obvious features, like symmetry, should be recognized.
2. Smaller sized elements are needed in zones of maximum interest and/or high stress gradients; larger elements may be used elsewhere.
3. Each region is divided into an appropriate number and type of elements whose node points are numbered sequentially. The cost of a solution depends heavily on the numbering sequence of nodes even if the total number of nodes and elements remain the same. A useful general rule is to minimize the maximum difference between the highest and lowest node numbers in an element.

The next step is selection of the type of analysis, such as number of construction layers, number of increments of load in a given layer, interaction properties, no-tension in soil and other similar decisions. All information has to be digitized and checked for correctness.





## CHAPTER II. COMPUTER PROGRAM

## 1. Types of Finite Elements

Several types of finite elements have been used in the program FINLIN. Description of each type follows.

Type I, Curved Bar Element

Segments of a ring have been used to represent flexible pipe, which has small thickness compared to the radius. Figure 1 shows a typical Type I element with two nodes, each node having three degrees of freedom - radial, tangential and rotational. The radius of the pipe, its stiffness  $EI$  (young's modulus times moment of inertia), and the nodal coordinates need to be defined. The position of the center of curvature is also necessary.

Type II, Interaction Element

This is a zero thickness, rectangular element with four nodes, each node having two degrees of freedom in the normal and tangential directions. Figure 2 shows a typical interaction element where the coordinates of nodes 1 and 4 (and 2 and 3) are initially the same. Coordinates of all four nodes, stiffness values in normal and tangential directions,  $E_n$  and  $E_s$  respectively, need to be defined. The program will modify the values of  $E_n$  and  $E_s$  according to the state of stress in these elements.

For both Type I and Type II elements, the program will perform the necessary coordinate transformation depending upon their position and orientation.

Type III, Isoparametric Triangular Element

This type of triangular element has three corner nodes and three intermediate (midpoint) nodes, each node having two degrees of freedom (Figure 3). The face 1-4-2 can be a



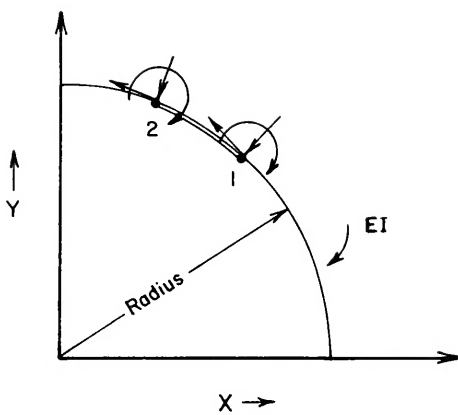


Figure 1. Type - I, Curved Bar Element



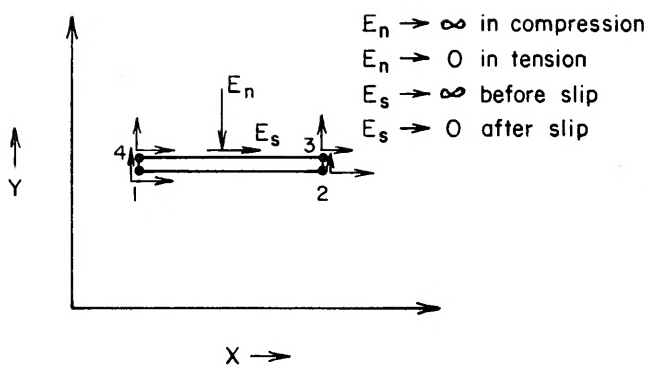


Figure 2. Type - II, Interaction Element



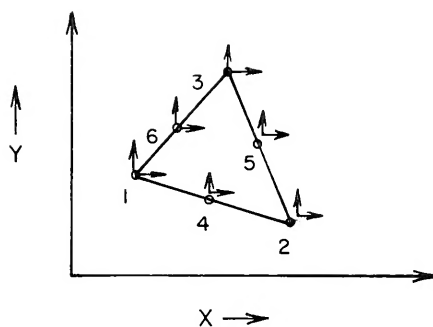


Figure 3. Type -III, Isoparametric Triangular Element





curved boundary. Nodes of the Type III element must be defined in the order shown in Figure 3. Coordinates of only corner nodes need to be defined. This element is used to simulate the soil medium and for thick pipes where rotation at pipe nodes are not significant. Required material properties for this type of element are modulus and poisson's ratio. Depending upon the nature of the material, linear or nonlinear properties can be used.

In case of analysis with no interaction element between pipe and soil, placing Type III element adjacent to Type I elements causes a difficulty in numerical procedure because nodes of 2 and 3 degrees of freedom lie at one point. To eliminate this problem Type IV and Type V elements are used. Type IV element (Figure 4) has the face 1-4-2 adjacent to the pipe. For Type V element (Figure 5) node 3 touches the pipe. Improper representation of elements will cause abnormal termination of the program.

#### Material Properties for Type III Elements

The program is capable of using linear, nonlinear and anisotropic material properties. Also different types of soils with distinct properties can be used. For linear materials only values of Young's modulus  $E$  and Poisson's ratio  $\nu$  need to be defined. For anisotropic material, the ratio of moduli in vertical to horizontal direction has to be defined. For nonlinear properties, experimental data are directly used. It is to be noted that, in this program tangent modulus and tangent Poisson's ratio values are used for incremental analysis. Also octahedral normal and shear stresses have been used in the formulation. Nonlinear soil properties for any value of stress level and stress ratio are interpolated using cubic spline functions.

It is necessary to convert conventional test data (e.g. Figure 6) to a form which is acceptable to this program, as follows:



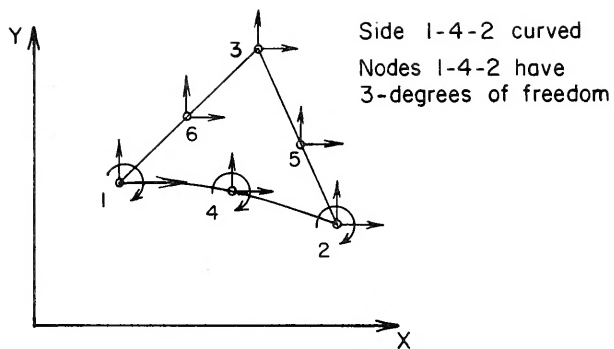


Figure 4. Type - IV, Triangular Element



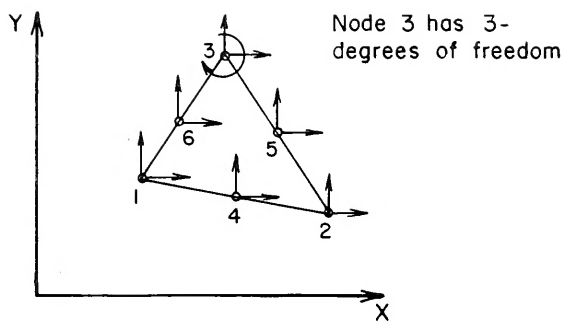


Figure 5. Type - V , Triangular Element



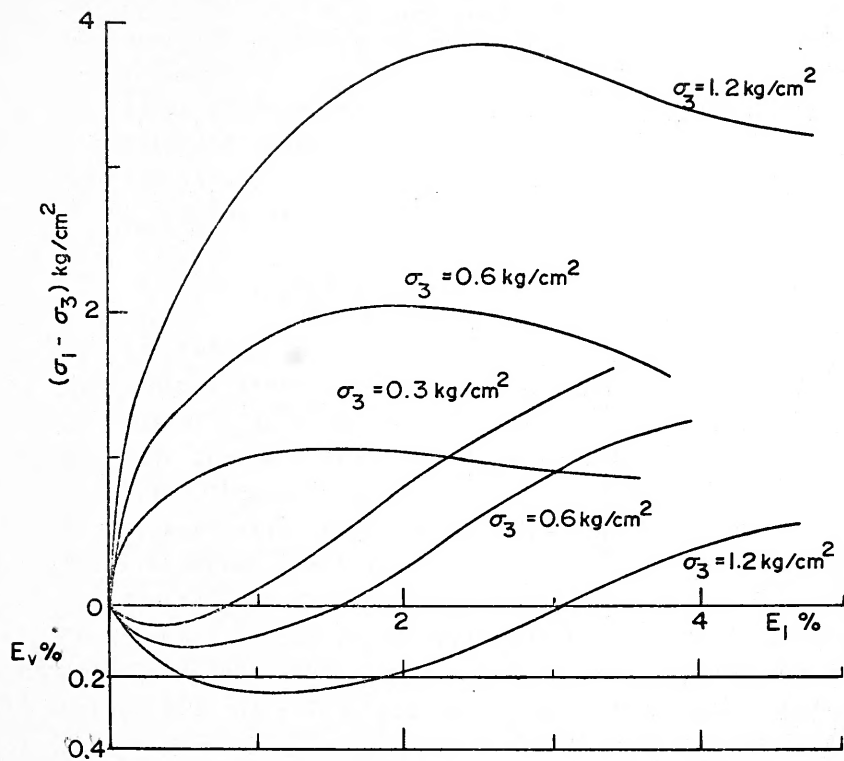


Figure 6, Plane Strain Test on Loose Monterey No. 0 Sand (after Lade, 1972)





1. Select successive values of  $(\sigma_1 - \sigma_3)$ ,  $\epsilon_v$  and  $\epsilon_1$  from the test data, at a given  $\sigma_3$  starting from zero.
2. Cubic splines are fitted to the data.
3. Small increments of  $\epsilon_1$  are chosen, and values of  $\sigma_2$ ,  $E_t$  and  $\nu_t$  are computed from the generalized Hooke's Law. With  $\sigma_1$ ,  $\sigma_2$ , and  $\sigma_3$  known, values of  $\sigma_{oct}$  and  $\tau_{oct}$  and  $\tau_{oct}/\tau_{oct \text{ failure}}$  are calculated.
4. Step (3) is repeated for each increment of  $\epsilon_1$  up to failure.
5. Steps (1) through (4) are repeated for all curves with different  $\sigma_3$ .
6. All values of  $E_t$  are plotted against corresponding  $\sigma_{oct}$ , and values of stress ratio

$$\left( \frac{\tau_{oct}}{\tau_{oct \text{ failure}}} \right)$$

are noted for all points.

7. Contour lines are drawn for selected values of stress ratio. For convenience, values of stress-ratio are made to range from zero to unity with increments of 0.1. This will generate 11 curves of  $E_t$  vs  $\sigma_{oct}$  for stress ratio from 0 to 1 (see Figure 7).
8. Procedures similar to steps (6) and (7) are employed for tangent Poisson's ratio,  $\nu_t$ , (see Figure 8).

To aid this procedure of data reduction, a small computer program called "PROPRTY" can be helpful which will cover steps (1) through (5) and prints out data required for steps (6) and (8).

#### Description of the Computer Program

The program FINLIN has been divided into several primary sections which are called OVERLAYS. Each OVERLAY performs specific computations and stores the results for future use. Figure 9 shows the principal organization of the program and several OVERLAYS. Each OVERLAY consists of one main program



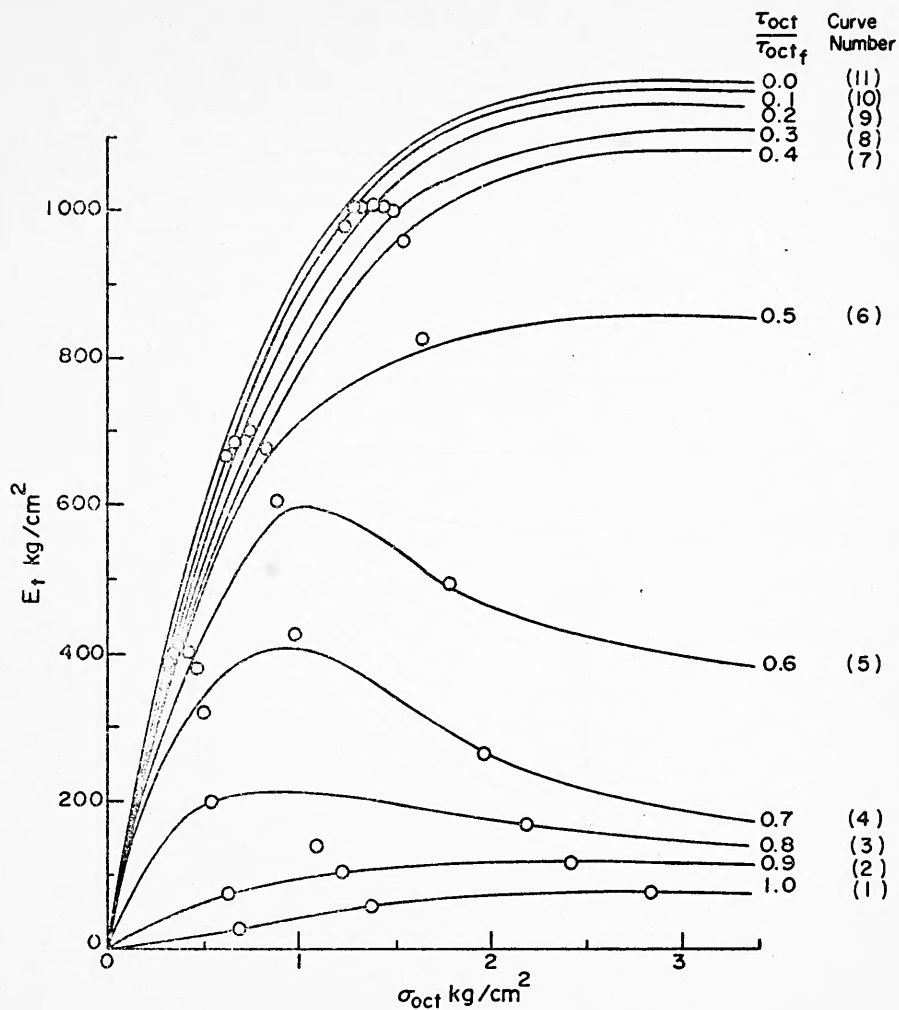


Figure 7 , Tangent Modulus vs. Octahedral Normal Stress and Failure Ratio for Loose Sand .



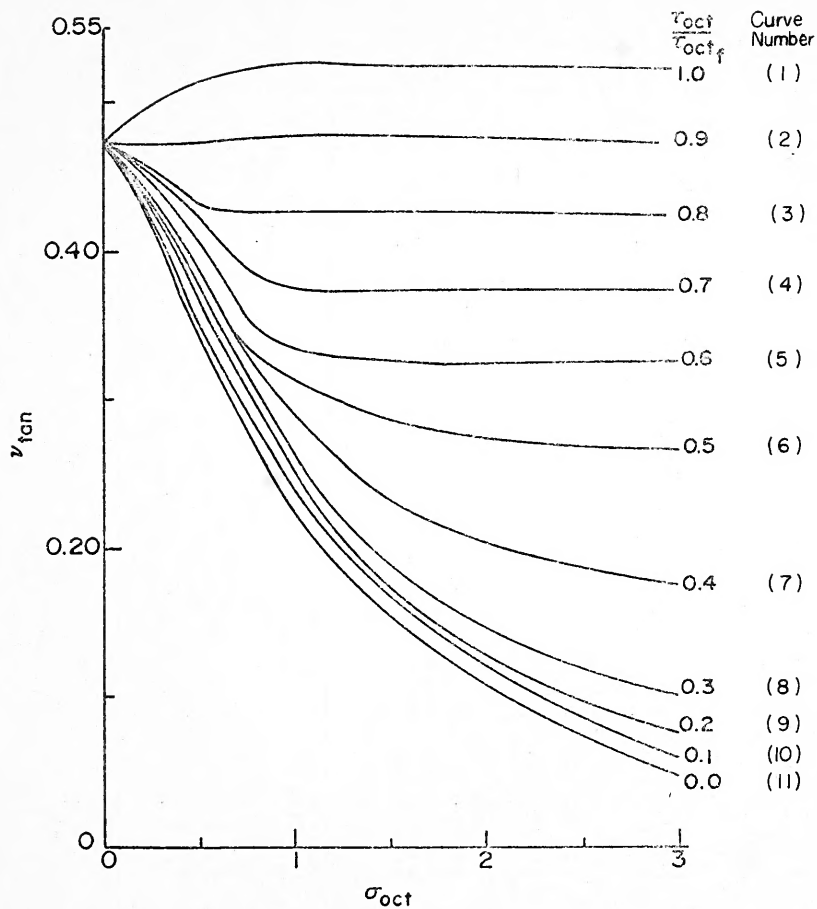


Figure 8 , Tangent Poisson's Ratio vs. Octahedral Normal Stress and Failure Ratio for Loose Sand.



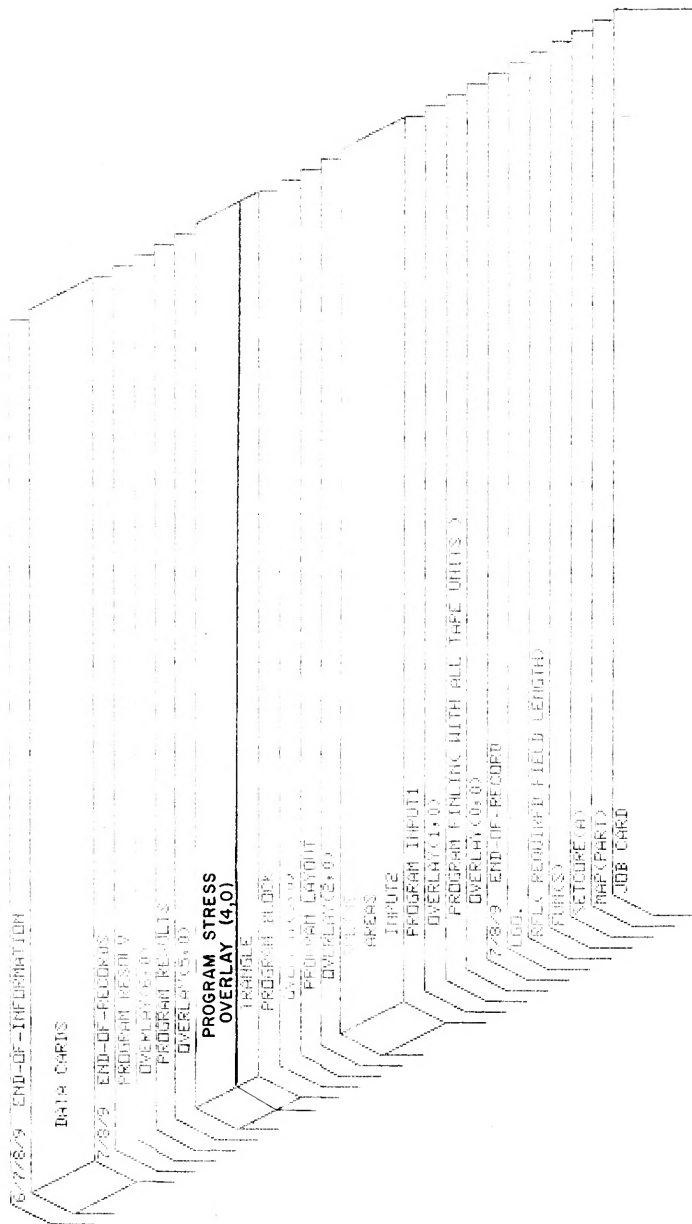


Fig. 9 ARRANGEMENT OF ROUTINES IN "FINLIN"





and several subroutines. OVERLAY 1 and 3 are the two most important sections of the program. Names of subroutines associated with OVERLAY 1 and 3 are shown in Figure 10. A general flow-chart of the program FINLIN is shown in Figure 11. Brief descriptions of the computations performed in OVERLAY (1.0) and (3.0) are given below.

INPUT1 -	Reads nodal and element data for all elements, material properties, pipe geometry and properties.
INPUT2 -	Reads modulus and Poisson's ratio value for linear elastic materials.
PLSTRS -	Computes elasticity matrix for plane stress condition.
PARAMTR -	Computes elasticity matrix for plane strain condition.
AREAS -	Area of triangular elements, and semi-band width for global stiffness matrix are evaluated in this routine.
SPLINE -	If nonlinear properties are specified, this routine reads data for non-linear analysis and stores them in a convenient form for future use.
SPLFIT -	Cubic spline fitting for nonlinear material properties is the primary function of this routine.
COFRIT -	Generates coefficients for cubic spline function.
TRIDGNL -	Solution of tridiagonal equation for spline fit.
FD and BD -	Foreward and backward interpolation formulae to determine slope.
ORDINET -	Spline-function interpolation formula.
FAILURE -	Function defining stress ratio at failure.



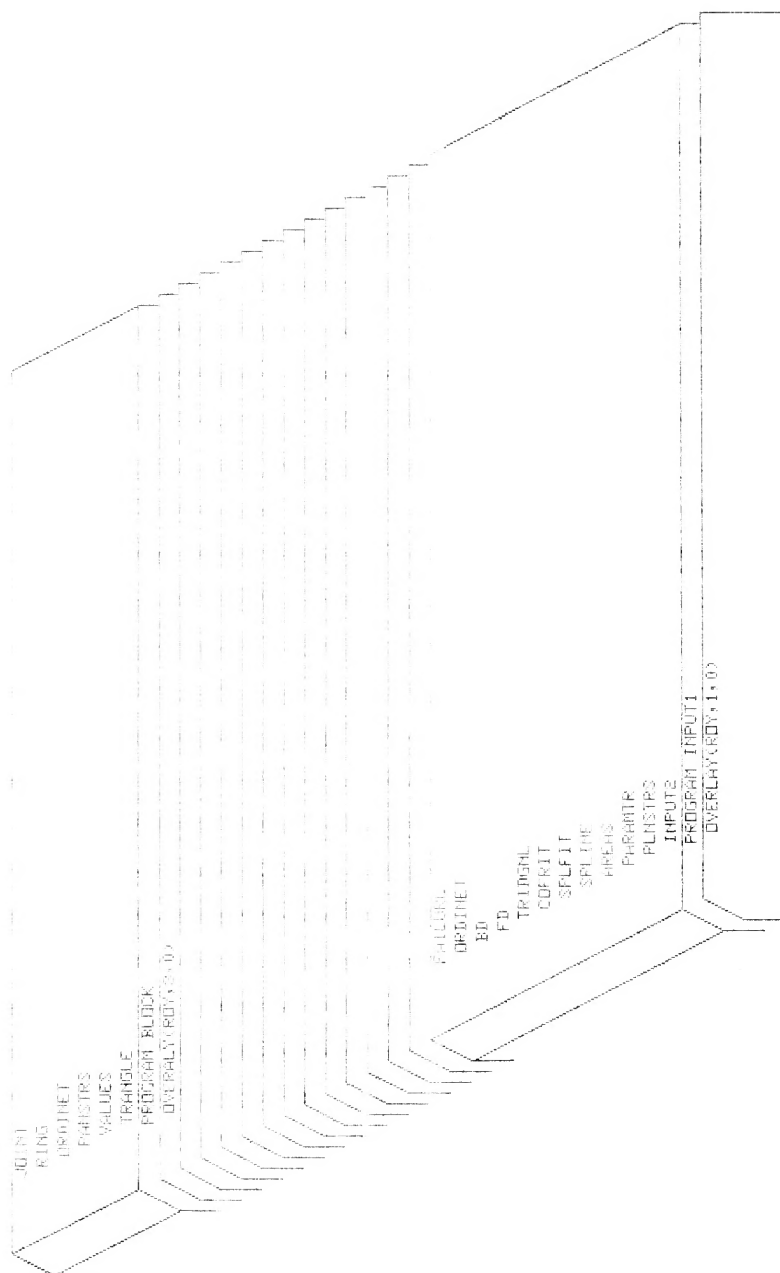


Fig. 10 SUBROUTINES IN OVERLAY (1.0) AND (3.0)



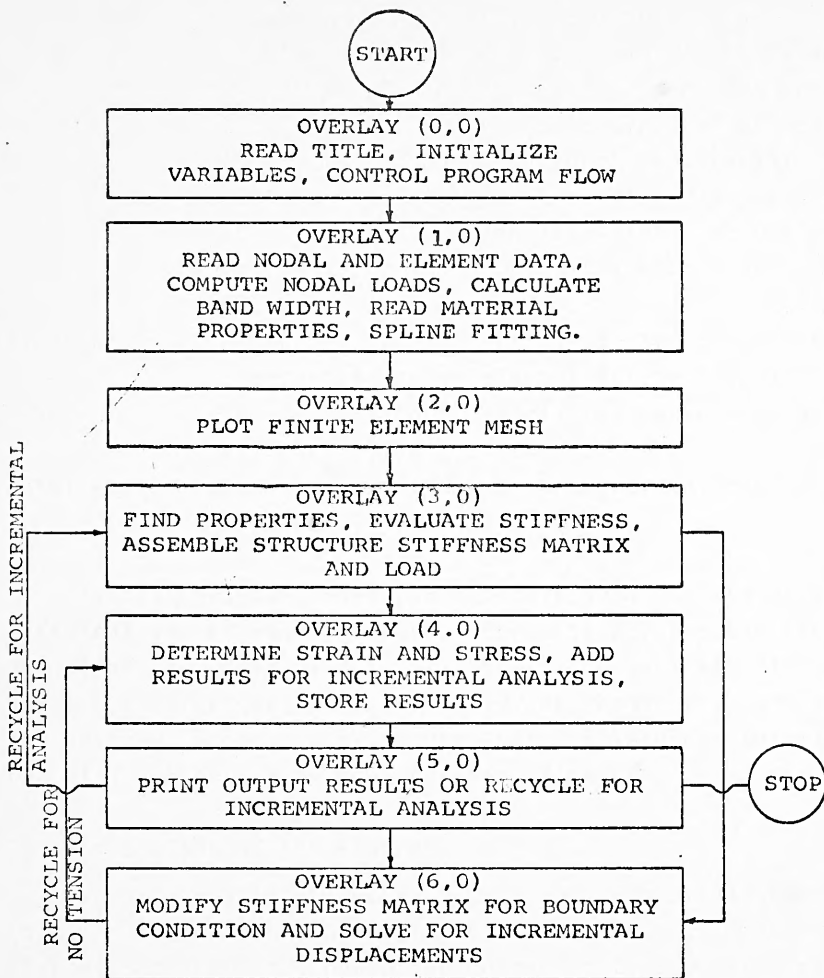


Figure 11 General Flow Chart of Program FINLIN



- BLOCK - This is the most important routine in FINLIN. Primary functions are (1) selection of elements in a given layer, (2) evaluation of nodal loads due to a given layer and number of increments of load, (3) generation of element stiffness matrix for all three basic types of elements, (4) modification of appropriate material properties for given state of stress condition, (5) formation of global stiffness matrix and load vector, (6) storing the matrix on tape for future use.
- TRANGLE - Evaluates element stiffness matrix for linear-strain-triangular elements (Type III, IV, V).
- RING - Creates stiffness matrix for curved-bar or ring elements (Type I).
- JOINT - Evaluates stiffness matrix for interaction elements (Type II).

In this program several means have been used to make efficient use of memory spaces. For this purpose the same locations have been used several times for entirely different purposes. If a user wants to modify or change any portion of the program, he should make sure that the intended changes do not wipe out or overwrite a portion of memory.

### 3. Limitations of the Program

In its present form the program takes about 112,000 (octal) core memory spaces to load and execute. FINLIN uses nine disc tape units, out of which two units are used for INPUT, OUTPUT, five for random access mass storage and two for intermediate storage purposes. Limitations of the program are listed below (they can be modified easily by changing a few cards):





- (1) Total number of nodes: (NNODES) = 550
- (2) Total number of elements: (NELEMNT) = 250
- (3) Different types of materials: (MATRIAL) = 25
- (4) Increments of stress ratio in Figure 7 and 8 = 0.1
- (5) Maximum number of points for nonlinear material properties = 7
- (6) Maximum semi-bandwidth for global stiffness matrix (including diagonal) = 103

However, semi-bandwidth capacity can be modified easily by making changes as follows:

- (a) Estimate the maximum semi-bandwidth (including the diagonal term). If it is even, add one and make it odd numbered, which is the final semi-bandwidth (N) of the system. Numerals in the indicated places should at least be N.
- (b) OVERLAY (0.0), Line: FLN-36, NSIZE = N
- (c) OVERLAY (3.0), Line: BLK-15  
DIMENSION A(N,N), ARRAY (N)
- (d) OVERLAY (6.0), Line: SOL-10  
DIMENSION A(N,2N), B(2N), ARRAY(N)
- (e) SUBROUTINE MODIFY, Line: 3  
DIMENSION A(N,2N), B(2N).



## CHAPTER III. INPUT DATA CARDS FOR PROGRAM "FINLIN"

1st Card Type: TITLE, MESH

FORMAT (13A 6, I2)

One card identifying the problem.

Col. 2-78: alphanumeric description of the problem to be printed in the output.

Co. 79-80: if greater than 0, a plot of finite element mesh is generated by CALCOMP plotter. If zero or blank, no plot is generated.

2nd Card Type: NNODES, NELEMNT, MATERIAL, NPRSR, LAYERS, ISTOP

FORMAT (2I5, 2I3, 2X, I2, 2X, I2)

One card defining problem.

Col. 1-5: NNODES - Total number of node points.

Col. 6-10: NELEMNT - Total number of elements (all types included).

Col. 11-13: MATERIAL - Total number of different soil types.

Col. 14-16: NPRSR - 0

Col. 19-20: LAYERS - Number of construction layers.

Col. 23-24: ISTOP - If zero, linear elastic soil properties, if greater than zero, nonlinear soil properties.

3rd Card Type: NTYPE, GAMA, TYPE

FORMAT (I5, F10.0, 10A6)

Soil type cards, one card for each soil type, total number = MATERIAL

Col. 1-5: NTYPE - Soil-type identification number.

Col. 6-15: GAMA - Unit weight of soil.

Col. 16-75: TYPE - Alphanumeric description of this soil type.



4th Card Type: ANLSIS, DELTA

FORMAT (A6, F5.0)

One card specifying type of analysis and angle of friction between soil and pipe.

Col. 1-6: PLSTRS - For plane-stress analysis.

PLSTRN - For plane-strain analysis.

Col. 7-11: DELTA - Angle of friction between pipe material and soil adjacent to pipe, in degrees.

5th Card Type: Two cards per soil material type, total number = 2X MATERIAL, specifying initial modulus and Poisson's ratio for each soil type.

(a) 1st Card - E

FORMAT (E10.0)

Col. 1-8: E - Initial modulus.

(b) 2nd Card - NUE

FORMAT (F5.0)

Col. 1-5: NUE - Initial Poisson's ratio.

6th Card Type: These cards are required only for nonlinear materials i.e. if ISTOP is greater than zero (in 2nd Card Type). This set of cards is repeated for each nonlinear soil type. If ISTOP = 0 or blank, these cards are not required.

(a) NP, PSI, PHI, ANISO, DELTA, FACTOR

FORMAT (I5, 5F10.0)

One card identifying soil properties.

Col. 1-5: NP - Number of points on each tangent modulus and tangent Poisson's ratio vs.  $\sigma_{oct}$  curve.

Col. 6-15: PSI - Factor defined as

$$\Psi = \frac{\sigma_2}{(\sigma_1 + \sigma_3)}$$

Col. 16-25: PHI - Friction angle for soil, in degrees.

Col. 26-35: ANISO - Anisotropy ratio,

$$\frac{E_x}{E_y}$$

If isotropic, ANISO = 1.0



- Col. 36-45: DELTA - Angle of friction, in degrees between pipe and soil.
- Col. 46-55: FACTOR - Conversion factor for  $\sigma_{oct}$  and tangent modulus, e.g.  $\sigma_{oct} = \text{FACTOR} * \sigma_{oct}$  and  $E_t = \text{FACTOR} * E_t$ .  
If no conversion is required, FACTOR = 1.0

## (b) XP(I)

FORMAT (8F10.0)

$\sigma_{oct}$  values of nonlinear property cards, total number values = NP, up to 8 values per card.

- Col. 1-10: NP(1) - 1st value of  $\sigma_{oct}$ .
- Col. 11-20: NP(2) - 2nd value of  $\sigma_{oct}$ .  
and so on.

## (c) EP, PSNR

FORMAT (2F10.0)

These set of cards define the nonlinear material properties. Two sets of curves are required

(1) for tangent modulus,  $E_t$  vs  $\sigma_{oct}$  for stress-ratio ranging from 0.0 to 1.0 and (2) same type of curves for tangent Poisson's ratio  $\nu_t$ , each curve of  $E_t$  and  $\nu_t$  is defined by NP number of points, so total number of cards = NP x 11.

- Col. 1-10: EP - Tangent modulus value.

- Col. 11-20: PSNR - Tangent Poisson's ratio value

Note: (1) First NP cards should read the values of  $E_t$  and  $\nu_t$  for increasing values of  $\sigma_{oct}$  starting from  $\sigma_{oct} = 0$ .

(2) The first set of NP cards are for curve of stress ratio = 1. The second set of NP cards will stand for stress ratio = 0.9 and so on. The last set of NP cards will read values of  $E_t$  and  $\nu_t$  for stress-ratio = 0.0.





(3) A set of cards which includes cards from (a) to (c), define a complete set of Type 6 cards. As no material number has been attached to it, the sequence in which the set of cards are placed, will define the soil type. For example, the first complete set of type 6 cards (which includes (a), (b) and (c) type cards) will automatically be defined for Type 1 (NTYPE in 3rd Card Type) soil and the second set of type 2 and so on.

7th Card Type: NREAD, FACTOR  
FORMAT (I5, F10.0)

Col. 1-5: NREAD - Total number of node point data cards. The triangular finite elements have six nodes i.e. three corner nodes and three mid-side nodes. Co-ordinates of mid-side nodes are calculated by the program. Except for defining boundary conditions, these nodes need not be defined.

Col. 6-15: FACTOR - Conversion factor for node point coordinates such as Ft. to Meter. If no conversion is required, FACTOR = 1.0.

8th Card Type: NN, NCODE, X, Y  
FORMAT (I5, 5X, I2, F10.0, 20X, F10.0)  
Nodal cards, one card per nodal point, total number = NREAD.

Col. 1-5: NN - Node point number.

Col. 11-12: NCODE - Node point boundary condition. The following table describes values of NCODE to represent desired boundary condition.



NCODE	Node Type	Boundary Condition
0	2 degrees of freedom in X and Y directions	Free X and Y directions.
1		Fixed in X and free in Y directions.
2		Free in X and fixed in Y directions.
3		Fixed in both X and Y directions.
4	3 degrees of freedom in X, Y direction and in rotation ( $\theta$ )	Free in X, Y and $\theta$ directions.
5		Fixed in X, free in Y and $\theta$ directions.
6		Fixed in Y, free in X and $\theta$ directions.
7		Fixed in $\theta$ , free in X and Y directions.
8		Fixed in X and $\theta$ , free in Y directions.
9		Fixed in Y and $\theta$ , free in X directions.

Col. 13-22: X - X co-ordinate of node point.

Y - Y co-ordinate of node point.

Nodal data cards may be placed in any order.

9th Card Type: IEL, IX

FORMAT (I3, 2X, 2(3I5, 5X), 4X, I1, 3X, I2)

Element cards, one card per element total  
number = NELEMNT Cards.

Col. 1-3: IEL - Element number.

Col. 6-10: IX(1) - Node number 1 of element no. IEL.

Col. 11-15: IX(2) - Node number 2 of element no. IEL.

Col. 16-20: IX(3) - Node number 3 of element no. IEL.

Col. 26-30: IX(4) - Node number 4 of element no. IEL.

Col. 31-35: IX(5) - Node number 5 of element no. IEL.

Col. 36-40: IX(6) - Node number 6 of element no. IEL.

Col. 50: IX(7) - Element type identification number.

Col. 54-55: IX(8) - Material type identification number.

Element types 1, 2, 3 and corresponding node numbers are shown in Figure 1 to Figure 3.

This numbering scheme has been used in the program. For type 4 and type 5 elements see Figures 4 and 5.

The element data cards can be placed in any order.



10th Card Type: ZAI(1), ZAI(2), ZAI(3)

FORMAT (3F10.0)

One card defining the point where stress of triangular element is required. (See Figure 12 for definition of ZAI).

Col. 1-10: ZAI(1) -

Col. 11-20: ZAI(2) - Area coordinates.

Col. 21-30: ZAI(3) -

11th Card Type: XCEN, YCEN, RADIUS, EI

FORMAT (3F10.0, E10.0)

One card defines center of circular pipe, radius and stiffness.

Col. 1-10: XCEN - X-coordinate of center of pipe.

YCEN - Y-coordinate of center of pipe.

RADIUS - Radius of pipe.

EI - Stiffness of pipe, Young's modulus times moment of inertia of pipe cross section per unit length.

12th Card Type: This card is required only when a plot of finite element mesh of the problem is required, which is specified in 1st Card Type. If Col. 79-80 is zero or blank no plot is generated. If any number is punched in Col. 79-80, a plot will be generated and in that case only this card is required.

XMAX, YMAX, YCEN

FORMAT (3F10.0)

Col. 1-10: XMAX - Maximum size of mesh in X-direction.

YMAX - Maximum size of mesh in Y-direction.

YCEN - Y-coordinate of center of pipe.



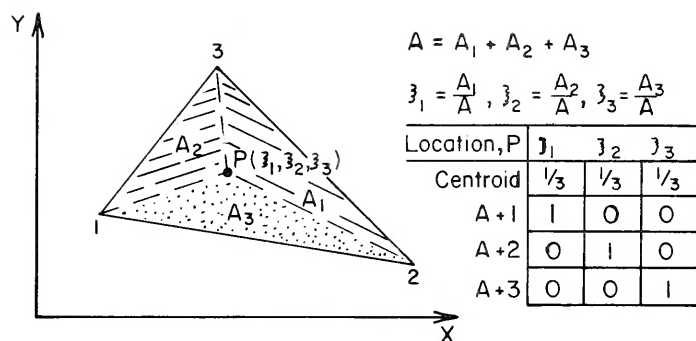


Figure 12. Definition of Area Co-ordinates





13th Card Type: NOTENSN, INTER, NSTEP, H1, H2, KN, KS, NITER  
 FORMAT (3I2, 4X, 2F10.0, 2E10.0, I5)

This card contains very important information regarding type of analysis required. Total number of cards = LAYERS (as specified in Col. 19-20 of 2nd Card Type).

Col. 1-2: NOTENSN = 0, if soil is allowed to take tension.  
               = 1, if 'no-tension' in soil analysis is required.

Col. 3-4: INTER = 0, if 'no-interaction' between soil and pipe is required in type II elements.  
               In this case, pipe and soil are rigidly connected.  
               = 1, if interaction between soil and pipe is desired which will permit slip depending upon the state of stresses in type II elements.

Col. 5-6: NSTEP - Number of equal increments of application of gravity load in a particular layer.

Col. 11-20: H1 - Starting height of a construction layer being analyzed.

Col. 21-30: H2 - Finish height of a construction layer being analyzed.

Col. 31-40: KN - Normal stiffness of pipe-soil interaction element (type II) before failure in tension.  
               In case tension develop in an interaction element, the program will modify value of this stiffness.

Col. 41-50: KS - Shear-stiffness of pipe-soil interaction element (type II) before failure. If INTER = 0, value of KN and KS are kept unchanged in all interaction elements throughout the analysis, which simulates rigid connection if values of KN and KS are considerably high. If INTER > 0 values of KN and KS are modified based on failure conditions specified for an interaction element.



Col. 51-55: NITER - Maximum number of iterations specified for 'no-tension' analysis. If the solution does not converge after specified number (= NITER) of iterations, farther execution will be stopped and a message will be printed.

#### Input Data Cards for Program 'PROPRTY'

In program FINLIN, an octahedral stress-strain system and tangent modulus and tangent Poisson's ratio values have been used for representing nonlinear soil properties. Required data for nonlinear properties in FINLIN (data card type 6), is difficult to get from conventional triaxial or plane strain tests.

In program FINLIN, some routine calculations and interpolations have to be performed to prepare data for card type 6. The program PROPRTY has been written to aid in generation of the data required for interpolation. This program accepts actual test data and interpolates using spline function, prints values of octahedral stress, strain, stress-ratio, tangent modulus, tangent Poisson's ratio and similar informations.

#### 1st Card Type: TITL

FORMAT (10A8)

Col. 2-80: TITL - Alphanumeric identification of soil and test; one card.

#### 2nd Card Type: TEST, NOCURVS, RF

FORMAT (A6, I3, F10.0)

One card defines type of test performed and other information.

Col. 1-6: TEST = PLSTRS for plane-stress test and  
= PLSTRN for plane-strain test performed  
on the sample.

Col. 7-9: NOCURVS - Number of confining pressures used in the test; should at least be three.

Col. 10-19: RF - Ratio of  $\tau_{oct}/\sigma_{oct}$  at failure.



3rd Card Type: SIGMA3, NP

FORMAT (5X, F10.0, I5)

One card specifies value of confining pressure and number of points for this test with given confining pressure.

Col. 6-15: SIGMA3 - Confining pressure.

Col. 16-20: NP - Number of points on a curve of given  $\sigma_3$ .

4th Card Type: XP, YP, VP

FORMAT (3F5.0)

One card per point, total number = NP; containing information about stress-strain and volume change data for a given  $\sigma_3$ .

Col. 1-5: XP - Axial strain in percent ( $\epsilon_1$  %).

Col. 6-10: YP - Deviator stress ( $\sigma_1 - \sigma_3$ ) corresponding to axial strain, XP.

Col. 11-15: VP - Volume strain in percent ( $\epsilon_v$  %).

Note: 3rd and 4th card types are repeated NOCURVS times.



APPENDIX - I

FINLIN  
PROGRAM LISTING





```

OVERLAY(ROY,0,0) FLN 1
C OVERLAY(ROY,0,0) FLN 2
C PROGRAM FINLIN (INPUT,OUTPUT,TAPE2,TAPE9,TAPE5=INPUT,TAPE6=OUTPUT,FLN 3
1TAPE1,TAPE3,TAPE4,TAPE7,TAPE10,PLOT) FLN 4
C FLN 5
C THIS FINITE ELEMENT PROGRAM HAS BEEN WRITTEN FOR PH.D. THESIS FLN 6
C PREDICTING PERFORMANCE OF PIPE CULVERTS IN SOIL FLN 7
C BY M. B. ROY, GRADUATE RESEARCH ASSISTANT FLN 8
C SCHOOL OF CIVIL ENGINEERING, GEOTECHNICAL ENGINEERING, FLN 9
C PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA - 47907 FLN 10
C DATE DECEMBER, 1975. FLN 11
C FLN 12
COMMON NNODES,NELEMNT,NDOF,NEAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,FLN 13
1NSTEP,NT12,ETA,NT1,NT2,NOTENH,IFLAG,NSIZE,NODE(550),X(550),Y(550,FLN 14
2),JNDX(51),ANLISIS,IX(8,250),AREAA(250),INDX(250),INDEX(250),GAMA(2FLN 15
35),ZAI(3) FLN 16
COMMON /1/ E,MUE,RADIUS,XCEN,YCEN,EI,KN,KS,H1,H2,INTER FLN 17
COMMON /2/ D FLN 18
COMMON /3/ P FLN 19
COMMON /4/ NDOU(26),DELTA FLN 20
COMMON /5/ D(1100),LIST(101) FLN 21
DIMENSION TITLE(13), R(1100), TEMP(17) FLN 22
DIMENSION E(10), MUE(10), D(10,10) FLN 23
REAL MUE FLN 24
REAL KN,KS FLN 25
C FLN 26
C THIS IS MAIN OVERLAY, WHICH DIRECTS EXECUTION OF OTHER OVERLAYS FLN 27
C DEPENDING UPON TYPE OF ANALYSIS AND OTHER COMMANDS FLN 28
C FOLLOWING TWO STATEMENTS ARE LIBRARY ROUTINES FOR FOR BLOCK AND STFLN 29
C FLN 30
CALL FINBIN (1,0) FLN 31
CALL SETSTAK (0) FLN 32
C FLN 33
C MAX. SIZE OF SEMI-BAND WIDTHOF TOTAL STIFFNESS MATRIX INCLUDING DIFLN 34
C FLN 35
NSIZE=103 FLN 36
NSTEP=1 FLN 37
IFLAG=0 FLN 38
REHIND 2 FLN 39
READ (5,55) TITLE,MESH FLN 40
IF (EOF,5) 5,10 FLN 41
5 GO TO 40 FLN 42
10 CONTINUE FLN 43
CALL ZERO (P,1100) FLN 44
WRITE (2) (R(I),I=1,1100) FLN 45
ISTEP=1 FLN 46
WRITE (6,60) TITLE FLN 47
C FLN 48
C CREATE MASS STORAGE FILES FLN 49
C INITIALISE MASS STORAGE UNITS FLN 50
C FLN 51
CALL OPENMS (1,INDX,250,0) FLN 52
CALL OPENMS (3,INDEX,250,0) FLN 53
CALL OPENMS (4,NDOU,26,0) FLN 54
CALL OPENMS (7,JNDX,51,0) FLN 55
CALL OPENMS (10,LIST,1100,0) FLN 56
ND=NSIZE FLN 57
C FLN 58
C OVERLAY(1,0) READS PROBLEM GEOMETRY AND MATERIAL PROPERTIES FLN 59

```



C	CALL OVERLAY (SHRDY,1,0,6HRECALL)	FLN	60
C	IF (MESH.GT.0) CALL OVERLAY (SHRDY,2,0,6HRECALL)	FLN	61
C	CALL ZERO (TEMP,17)	FLN	62
C	DO 15 I=1,NLEVRNT	FLN	63
C	CALL WRITAS (1,TEMP,17,I)	FLN	64
C	15 CONTINUE	FLN	65
C		FLN	66
C	FOLLOWING PARAMETERS DESCRIBE TYPE OF ANALYSIS DESIRED	FLN	67
C	NOTENSH .GT. 0 = NO-TENSION ANALYSIS, = 0 = NO CHECK FOR TENSION	FLN	68
C	INTER .GT. ZERO = INTERACTION, INTER=0, NO INTERACTION	FLN	69
C	NSTEP = NO. OF INCREMENTS PER LAYER	FLN	70
C	H1 = STARTING HEIGHT OF THIS LAYER	FLN	71
C	H2 = ENDING HEIGHT OF THIS LAYER	FLN	72
C	KN = NORMAL STIFFNESS FOR INTERACTION	FLN	73
C	KS = SHEAR STIFFNESS FOR INTERACTION	FLN	74
C	NITER = NO. OF ITERATION SPECIFIED FOR NO-TENSION ANALYSIS	FLN	75
C		FLN	76
C	20 READ (5,65) NOTENSH,INTER,NSTEP,H1,H2,KN,KS,NITER	FLN	77
C	NCYCLE=1	FLN	78
C	WRITE (6,70) INTER,NSTEP,H1,H2,NOTENSH	FLN	79
C	25 ND=NSIZE	FLN	80
C	NCOUNT=0	FLN	81
C		FLN	82
C	FORM STRUCTURAL STIFFNESS MATRIX AND LOAD VECTOR	FLN	83
C		FLN	84
C	CALL OVERLAY (SHRDY,3,0,6HRECALL)	FLN	85
C	WRITE (6,75)	FLN	86
C		FLN	87
C	MODIFY FOR BOUNDARY CONDITIONS	FLN	88
C	SOLVE FOR DISPLACEMENT	FLN	89
C		FLN	90
C	CALL OVERLAY (SHRDY,6,0,6HRECALL)	FLN	91
C		FLN	92
C	FIND STRESSES AND STRAINS, AND PRINT RESULTS	FLN	93
C		FLN	94
C	30 CALL OVERLAY (SHRDY,4,0,6HRECALL)	FLN	95
C	CALL OVERLAY (SHRDY,5,0,6HRECALL)	FLN	96
C	IF (IFLAG.LE.0) GO TO 35	FLN	97
C		FLN	98
C	RECYCLE FOR NO-TENSION	FLN	99
C		FLN	100
C	NCOUNT=NCOUNT+1	FLN	101
C	IF (NCOUNT.GT.NITER) GO TO 50	FLN	102
C	CALL OVERLAY (SHRDY,6,0,6HRECALL)	FLN	103
C	GO TO 30	FLN	104
C		FLN	105
C	RECYCLE PROGRAM FOR INCREMENTAL OR NON-LINEAR ANALYSIS	FLN	106
C		FLN	107
C	35 NCYCLE=NCYCLE+1	FLN	108
C	IFLAG=0	FLN	109
C	IF (NCYCLE.GT.NSTEP) GO TO 40	FLN	110
C	GO TO 25	FLN	111
C	40 ISTEP=ISTEP+1	FLN	112
C	IF (ISTEP.GT.LAYERS) GO TO 45	FLN	113
C	GO TO 20	FLN	114
C	45 WRITE (6,80)	FLN	115
C		FLN	116
C		FLN	117
C	CLOSE ALL MASS STORAGE UNITS	FLN	118
C		FLN	119



```

      CALL CLOSEMS (1)          FLN 120
      CALL CLOSEMS (3)          FLN 121
      CALL CLOSEMS (4)          FLN 122
      CALL CLOSEMS (7)          FLN 123
      CALL CLOSEMS (10)         FLN 124
C
      STOP                      FLN 125
50 WRITE (6,85) NCDUNT          FLN 126
      STOP                      FLN 127
C
55 FORMAT (13A6,12)            FLN 128
60 FORMAT (20X,15A6)           FLN 129
65 FORMAT (812,4X,2F10.0,2E10.0,15) FLN 130
70 FORMAT (/10X, 17H' LAYER INFORMATION: /10X, 14H' INTERACTION = ,15/10X, FLN 131
   1 35HND. OF INCREMENTS FOR THIS LAYER = ,15/10X, 32H' STARTING HEIGHT FLN 132
   2 OF THIS LAYER = ,F10.2/10X, 32H' FINISHING HEIGHT OF THIS LAYER = ,FLN 133
   3F10.2/10X, 14H' NO-TENSION = ,15/10X, 30HND. OF ITERATIONS SPECIFIED FLN 134
   4D = ,15/10X)              FLN 135
75 FORMAT (10X, 23H' OVERLAY = 3,0) (COMPLETED) FLN 136
80 FORMAT (///5X, 15H' END OF PROBLEM') FLN 137
85 FORMAT (///10X, 45HND-TENSION ITERATION DOES NOT CONVERGE AFTER ,1FLN 138
   15, 13H' ITERATIONS, /10X, 20H' EXECUTION TERMINATED) FLN 139
C
      END                      FLN 140
      SUBROUTINE ZFDD (A,N)     FLN 141
      ZRD 2
C
      ZRD 3
C
      *****
C
      THIS SUBROUTINE GENERATES A NULL VECTOR ZRD 4
C
      *****
C
      ZRD 5
C
      ZRD 6
C
      ZRD 7
      DIMENSION A(N)           ZRD 8
      DO 5 I=1,N               ZRD 9
        A(I)=0.0              ZRD 10
5 CONTINUE                    ZRD 11
      RETURN                   ZRD 12
C
      END                      ZRD 13
      SUBROUTINE NULLMAT (A,M,N) NUL 2
C
      NUL 3
C
      THIS ROUTINE GENERATES A NULL MATRIX A = A * OF SIZE (M X N) NUL 4
C
      NUL 5
C
      DIMENSION A(N,N)         NUL 6
      DO 5 J=1,N               NUL 7
        DO 5 I=1,N             NUL 8
          A(I,J)=0.0           NUL 9
5 CONTINUE                    NUL 10
      RETURN                   NUL 11
C
      END                      NUL 12
      OVERLAY(CRD,1,0)         INI 1
C
      OVERLAY(CRD,1,0)         INI 2
C
      PROGRAM INPUT            INI 3
      COMMON /NODES, RELEMT, NDC, NBRAND, ND, PTS, ISTOP, NOCYCLE, LAYERS, ISTEP, INI 4
      INSTEP, HT12, ET1, HT1, HT2, NO-TENSION, IFLAG, NSIZE, NCODE(550), X(550), Y(550) INI 5
      Z, UNIX(51), ANALYSIS, IX(8,250), AREA(250), INDX(250), INDEX(250), GAMMA(2 INI 6
      35), ZAT(3)              INI 7
      COMMON /1/ E, RUE, RADIUS, XCEN, YCEN, EI, KN, KS, H1, H2, INTER INI 8
      COMMON /2/ D             INI 9
      COMMON /4/ MODU(26), DELTA INI 10
      DIMENSION E(10), RUE(10), D(10,10) INI 11

```



	DIMENSION TYPE(10)	IN1	12
	DIMENSION NL(4)	IN1	13
	DATA MAXHP,MAXEL,MAXMAT/350,250,25/	IN1	14
	DATA PLSTRN,PLSTRN/6HPLSTRN,6HPLSTRN/	IN1	15
	REAL KZERO	IN1	16
	REAL KN,KS	IN1	17
	REAL HUE	IN1	18
	NT3=0	IN1	19
	HDOF=0	IN1	20
	MBAND=0	IN1	21
	NT1=0	IN1	22
	NT2=0	IN1	23
	NT12=0	IN1	24
C		IN1	25
C	READ PROBLEM STATEMENT AND OTHER PARAMETERS	IN1	26
C		IN1	27
	READ (5,75) NNODES,NELEM,NT,MATRIAL,NPRSR,LAYERS,ISTOP	IN1	28
	IF (NNODES.LE.NANP) GO TO 5	IN1	29
	WRITE (6,80) NNODES	IN1	30
5	IF (NELEM,NT,MAXEL) GO TO 10	IN1	31
	WRITE (6,85) NELEM,NT	IN1	32
C		IN1	33
C	*****	IN1	34
C	PRINT LAYOUT OF THE PROBLEM	IN1	35
C	*****	IN1	36
C		IN1	37
10	WRITE (6,90) NNODES,NELE,NT,MATRIAL,NPRSR,LAYERS	IN1	38
	IF (MATRIAL.LE.MAXMAT) GO TO 15	IN1	39
	WRITE (6,95) MATRIAL	IN1	40
15	CONTINUE	IN1	41
C		IN1	42
C	*****	IN1	43
C	READ MATERIAL TYPES, PROPERTIES AND DESCRIPTION	IN1	44
C	*****	IN1	45
C		IN1	46
	WRITE (6,105)	IN1	47
	CALL ZERO (GAMA,25)	IN1	48
	DO 20 I=1,MATRIAL	IN1	49
	READ (5,100) NTYPE,GAMA(NTYPE),TYPE	IN1	50
	WRITE (6,110) NTYPE,GAMA(NTYPE),TYPE	IN1	51
20	CONTINUE	IN1	52
	READ (5,115) ANLSIS,DELTA	IN1	53
	DO 25 I=1,MATRIAL	IN1	54
	CALL INPUT2 (I)	IN1	55
	IF (ANLSIS.EQ.PLSTRN) CALL PLNSTR (I)	IN1	56
	IF (ANLSIS.EQ.PLSTRN) CALL PARANTR (I)	IN1	57
C		IN1	58
C	IF ISTOP.GT. 2)RD; NON-LINEAR PROPERTY SPECIFIED	IN1	59
C		IN1	60
	IF (ISTOP.GT.0) CALL SPLINE (I)	IN1	61
25	CONTINUE	IN1	62
C		IN1	63
C	*****	IN1	64
C		IN1	65
	CALL ZERO (X,NNODES)	IN1	66
	CALL ZERO (Y,NNODES)	IN1	67
	CALL ZERO (NCODE,550)	IN1	68
C		IN1	69
C	READ NODAL POINT DATA; CODE, COORDINATES, LOADS, ETC.	IN1	70
C	MREAD = TOTAL NO. OF NODAL DATA CARDS SUPPLIED	IN1	71





C	FACTOR = UNIT CONVERSION FACTOR FOR NODAL COORDINATE DATA	IN1	72
C		IN1	73
	READ (5,120) NREAD,FACTOR	IN1	74
	DO 30 I=1,NREAD	IN1	75
	READ (5,125) NN,NCODE,NN,X(NN),Y(NN)	IN1	76
	IF (NCODE>NN).GT.3) NT3=NT3+1	IN1	77
	X(NN)=X(NN)*FACTOR	IN1	78
	Y(NN)=Y(NN)*FACTOR	IN1	79
30	CONTINUE	IN1	80
C		IN1	81
C	*****	IN1	82
C	READ ELEMENT DATA, TYPE, MATERIAL	IN1	83
C		IN1	84
	CALL NULLMAT (IX,8,NELEMT)	IN1	85
	CALL ZERO (AREAR,NELEMT)	IN1	86
	DO 35 I=1,NELEMT	IN1	87
	READ (5,130) IEL,(IX(J,IEL),J=1,8)	IN1	88
	NT=IX(7,IEL)	IN1	89
	IF (NT.EQ.1) NT1=NT1+1	IN1	90
	IF (NT.EQ.2) NT2=NT2+1	IN1	91
35	CONTINUE	IN1	92
	NT12=NT1+NT2	IN1	93
C		IN1	94
C	WRITE NODAL POINT INFORMATION	IN1	95
C		IN1	96
	WRITE (6,135)	IN1	97
	DO 40 I=1,NNODES	IN1	98
	WRITE (6,140) I,NCODE,I,X(I),Y(I)	IN1	99
40	CONTINUE	IN1	100
C		IN1	101
C	WRITE ELEMENT INFORMATION	IN1	102
C		IN1	103
	WRITE (6,145)	IN1	104
	DO 45 I=1,NELEMT	IN1	105
	WRITE (6,150) I,(IX(J,I),J=1,8)	IN1	106
45	CONTINUE	IN1	107
	READ (5,160) ZAI(1),ZAI(2),ZAI(3)	IN1	108
	WRITE (6,155) ZAI(1),ZAI(2),ZAI(3)	IN1	109
C		IN1	110
C	DETERMINE BAND WIDTH	IN1	111
C		IN1	112
C	DETERMINE NODAL FORCES DUE TO SELF WEIGHT, FOR THIS PURPOSE	IN1	113
C		IN1	114
	WRITE (6,165)	IN1	115
	DO 65 II=1,NELEMT	IN1	116
	NT=IX(7,II)	IN1	117
	GO TO (50,55,60,60,60), NT	IN1	118
50	I1=IX(1,II)	IN1	119
	I2=IX(2,II)	IN1	120
	IDF=I1-I2	IN1	121
	NBAND=(ABS(IDF)+1)*3	IN1	122
	IF (NBAND.GT.NBAND) NBAND=NBAND	IN1	123
	GO TO 65	IN1	124
55	I1=IX(1,II)	IN1	125
	I2=IX(2,II)	IN1	126
	I3=IX(3,II)	IN1	127
	I4=IX(4,II)	IN1	128
	NL(1)=3*I1-I2	IN1	129
	NL(2)=3*I2-I3	IN1	130
	NL(3)=2*I3-I4+NT3	IN1	131



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      NL(4)=2*I4-1+NT3                      IN1 132
      MAX=MAX0(NL(1),NL(2),NL(3),NL(4))      IN1 133
      MIN=MIN0(NL(1),NL(2),NL(3),NL(4))      IN1 134
      NBAND=MAX-MIN+2                        IN1 135
      IF (NBAND.GT.MBAND) MBAND=NBAND         IN1 136
      GO TO 65                               IN1 137
60    CALL AREAS (II,NT)                     IN1 138
65    CONTINUE                               IN1 139
      NDOF=2*NNOES+NT3                       IN1 140
C
C      PRINT SIZE OF THE PROBLEM              IN1 141
C
C      WRITE (6,170) NDOF,MBAND              IN1 142
C
C      IF (NT3.LE.0) GO TO 70                IN1 143
C
C      READ CENTER, RADIUS, AND EI OF PIPE   IN1 144
C
C      READ (5,175) XCEN,YCEN,RADIUS,EI      IN1 145
C      WRITE (6,180) XCEN,YCEN,RADIUS,EI     IN1 146
C
C      DETERMINE ETA FOR TRIANGULAR ELEMENTS IN1 147
C
C      NT12P1=NT12+1                         IN1 148
C      IF (NT12P1.GT.NELEMNT) GO TO 70       IN1 149
C      I1=IX(1,NT12P1)                       IN1 150
C      I2=IX(2,NT12P1)                       IN1 151
C      X1=X(I1)                              IN1 152
C      Y1=Y(I1)                              IN1 153
C      X2=X(I2)                              IN1 154
C      Y2=Y(I2)                              IN1 155
C      SPAN=SQRT((X1-X2)**2+(Y1-Y2)**2)      IN1 156
C      CH=0.5*SPAN/RADIUS                    IN1 157
C      TH=ASIN(CH)                           IN1 158
C      THETA=2.*TH                           IN1 159
C      R2=RADIUS**2                          IN1 160
C      A1=0.5*THETA*R2                       IN1 161
C      A2=0.5*R2*SIN(THETA)                 IN1 162
C      A4=A1-A2                              IN1 163
C      ETA=A4/APEAA(NT12P1)                 IN1 164
C      ETA=0.0                              IN1 165
C
C      70 CONTINUE                           IN1 166
C      WRITE (6,185)                          IN1 167
C      RETURN                                IN1 168
C
C      75 FORMAT (2I5,2I3,2X,I2,2X,I2,1X,I1,1X,I2) IN1 169
C      80 FORMAT (5X, 42HNO. OF NODES EXCEEDS LIMIT(=900), NNOES=,I5) IN1 170
C      85 FORMAT (5X, 46HNO. OF ELEMENTS EXCEEDS LIMIT(=500), NELEMNT=,I5) IN1 171
C      90 FORMAT (10X, 19HPROBLEM DESCRIPTION,/,5X, 19HNO. OF NODE POINTS=,I1 IN1 172
C      15/5X, 16HNO. OF ELEMENTS=,I5/5X, 17HNO. OF MATERIALS=,I5/5X, 26HNO IN1 173
C      2. OF BOUNDARY PRESSURES=,I5/5X, 29HNO. OF CONSTRUCTION LAYERS =,I1 IN1 174
C      35//)                                  IN1 175
C      95 FORMAT (5X, 47HNO. OF MATERIALS EXCEEDS LIMIT (= 25), MATRIAL=,I5) IN1 176
C      100 FORMAT (15,F10.0,10A6)              IN1 177
C      105 FORMAT (///10X, 21HMATERI AL DESCRIPTIONS,/,5X, 3HNO.,5X, 11HUNIT IN1 178
C      10EIGHT,10X, 11HDESCRIPTION,/,)
C      110 FORMAT (5X, I2,8X,F8.4,10X,10A6)     IN1 179
C      115 FORMAT (A6,F5.0)                   IN1 180
C      120 FORMAT (15,F10.0)                  IN1 181

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125 FORMAT (I5,5X,I2,F10.0,20X,F10.0) IN1 192
130 FORMAT (I3,2X,2(3I5,5X),4X,I1,3X,I2,2F5.0,5X,2F5.0) IN1 193
135 FORMAT (///10X, 16HNODAL POINT DATA,///5X, 8HNODE NO.,2X, 9HDIRECIN1 194
11IDN,3X, 10HFIXED/FREE,5X, 11HCO-ORDINATE,5X, 10HNODAL LOAD,2X, 9IN1 195
2HDIRECTION,3X, 10HFIXED/FREE,5X, 11HCO-ORDINATE,5X, 10HNODAL LOAD,IN1 196
3/) IN1 197
140 FORMAT (7X,I4,8X, 1HX,10X,I1,11X,F8.2,24X, 1HY,22X,F8.2) IN1 198
145 FORMAT (///10X, 18HELEMENT DATA INPUT,///1X, 11HELEMENT NO.,2X, 59HIN1 199
1 -P- -Q- -R- -S- -PQ- -QR- -RP- -RS- TYPE MATERIAL,///) IN1 200
150 FORMAT (2X,I5,6X,3(I3,2X),5X,3(I4,2X),6X,2X,I2,5X,I3,4X,F6.1,2X,F6IN1 201
1.2,1X,F4.0,1X,F4.0) IN1 202
155 FORMAT (10X, 9HZAI(1) = ,F5.2,5X, 9HZAI(2) = ,F5.2,5X, 9HZAI(3)IN1 203
1 = ,F5.2/) IN1 204
160 FORMAT (3F10.0) IN1 205
165 FORMAT (/10X, 20HELEMENT INFORMATIONS,/,1X, 7HELE.NO.,9X, 6HZAI(1IN1 206
1),9X, 6HZAI(2),9X, 6HZAI(3),10X, 4HAREA,5X, 24HX-COORDINATE,Y-CIN1 207
2ORDINATE,/) IN1 208
170 FORMAT (///10X, 12HPROBLEM SIZE,///25X, 27HNO. OF DEGREES OF FREEDOMIN1 209
1N =,15/35X, 17HSEMI-BAND-WIDTH =,15/) IN1 210
175 FORMAT (3F10.0,E10.0) IN1 211
180 FORMAT (/10X, 19HPIPE SPECIFICATIONS,/,10X, 11HX-CENTER = ,F6.2,3X,IN1 212
1 11HY-CENTER = ,F6.2,/,10X, 14HPIPE RADIUS = ,F6.2,/,10X, 15HPIPE STIN1 213
2IFFNESS ,E12.2/) IN1 214
185 FORMAT (1X, 23HDOVERLAY (1,0) COMPLETED) IN1 215
C IN1 216
END IN1 217
SUBROUTINE INPUT2 (II) IN2 2
COMMON /1/ E,HUE,RADIUS,NCEN,YCEN,EI,KN,KS,H1,H2,INTER IN2 3
DIMENSION E(10), NUE(10) IN2 4
REAL KN,KS IN2 5
C IN2 6
C ***** IN2 7
C THIS ROUTINE READS DATA AND NECESSARY VARIATIONAL PARAMETERS FOR IN2 8
C MATERIAL PROPERTIES AND CONSTITUTIVE RELATIONSHIP. IN2 9
C THIS ROUTINE IS DIRECTLY CONNECTED TO #PARAMTR # THROUGH COMMON IN2 10
C IN2 11
REAL HUE IN2 12
C IN2 13
C READ E , NUE FOR FIXED PROPERTY IN2 14
C IN2 15
READ (5,5) E(II) IN2 16
READ (5,10) NUE(II) IN2 17
WRITE (6,15) II,E(II),NUE(II) IN2 18
RETURN IN2 19
C IN2 20
5 FORMAT (10E8.0) IN2 21
10 FORMAT (F5.0) IN2 22
15 FORMAT (////10X, 27HPROPERTIES FOR MATERIAL NO ,15,/,5X, 15HYOUNGSIN2 23
1 MODULUS=,1X,E11.4,5X, 15HPOISSONS RATIO=,F5.2) IN2 24
C IN2 25
END IN2 26
SUBROUTINE PLNSTRS (K) PLS 2
COMMON /1/ E,HUE,RADIUS,NCEN,YCEN,EI,KN,KS,H1,H2,INTER PLS 3
COMMON /2/ D PLS 4
REAL NUE,HUEK PLS 5
REAL KN,KS PLS 6
DIMENSION D(10,10), E(10), NUE(10) PLS 7
C PLS 8
C THIS ROUTINE IS FOR PLANE STRESS PLS 9
C PLS 10

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	NUEK=HUE(K)	PLS	11
	C=E(K)/(1.-HUEK*HUEK)	PLS	12
	D(K,8)=0,0	PLS	13
	D(K,7)=D(K,8)	PLS	14
	D(K,6)=D(K,7)	PLS	15
	D(K,3)=D(K,6)	PLS	16
	D(K,5)=C	PLS	17
	D(K,1)=D(K,5)	PLS	18
	D(K,4)=C*HUEK	PLS	19
	D(K,2)=D(K,4)	PLS	20
	D(K,9)=0,5*C*(1.-HUEK)	PLS	21
	D(K,10)=HUEK	PLS	22
	RETURN	PLS	23
C	END	PLS	24
	SUBROUTINE PARAMTR (K)	PLN	25
	COMMON /1/ E, HUE, RADIUS, XGEN, YGEN, EI, KN, KS, H1, H2, INTER	PLN	2
	COMMON /2/ D	PLN	3
	REAL KN, KS	PLN	4
C		PLN	5
C	THIS ROUTINE IS FOR PLANE STRAIN	PLN	6
C		PLN	7
	REAL HUE, NUEK	PLN	8
	DIMENSION D(10,10), E(10), HUE(10)	PLN	9
	HUE=HUE(K)	PLN	10
	C=(E(K)*(1.-HUEK))/(1.+HUEK)*(1.-2.*HUEK)	PLN	11
	D(K,5)=C	PLN	12
	D(K,1)=D(K,5)	PLN	13
	D(K,4)=C*HUEK/(1.-HUEK)	PLN	14
	D(K,2)=D(K,4)	PLN	15
	D(K,9)=C*(1.-2.*HUEK)/(2.*(1.-HUEK))	PLN	16
	D(K,8)=0,0	PLN	17
	D(K,7)=D(K,8)	PLN	18
	D(K,6)=D(K,7)	PLN	19
	D(K,3)=D(K,6)	PLN	20
	D(K,10)=HUEK	PLN	21
	RETURN	PLN	22
C		PLN	23
	END	PLN	24
	SUBROUTINE AREAS (MN,NT)	ARE	25
	COMMON /NODES, NELEMT, NDAF, MEAND, ND, NT3, ISTOP, NCYCLE, LAYERS, ISTEP, ARE	ARE	2
	1NSTEP, NT12, ETA, NT1, NT2, NTENSH, IFLAG, NSIZE, NDOBE(550), X(550), Y(550)	ARE	3
	ARE(2), JNDX(51), ANLSIS, IX(8,250), AREA(250), INDX(250), INDEX(250), GAMMA(2	ARE	4
	95), ZAI(3)	ARE	5
	DIMENSION LM(6)	ARE	6
		ARE	7
C	*****	ARE	8
C	THIS ROUTINE CALCULATES ELEMENT AREA, AND SEMI BAND WIDTH	ARE	9
C		ARE	10
C	AREA=0,0	ARE	11
	I=IX(1,MN)	ARE	12
	J=IX(2,MN)	ARE	13
	K=IX(3,MN)	ARE	14
	MK=NT-2	ARE	15
	GO TO (5,15,20), MK	ARE	16
	5 DO 10 N=1,6	ARE	17
10	LM(N)=2*IX(N,MN)-NT3-1	ARE	18
	GO TO 30	ARE	19
15	LM(1)=3*IX(1,MN)-2	ARE	20
	LM(2)=3*IX(2,MN)-2	ARE	21
		ARE	22





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      LM(3)=2*IX(3,ND)-1+NT3      ARE 23
      LM(4)=2*IX(4,ND)-2          ARE 24
      LM(5)=2*IX(5,ND)-1+NT3      ARE 25
      LM(6)=2*IX(6,ND)-1+NT3      ARE 26
      GO TO 30                     ARE 27
20 DO 25 N=1,6                    ARE 28
25 LM(N)=2*IX(N,ND)-1+NT3        ARE 29
      LM(3)=2*IX(3,ND)-2          ARE 30
30 AREA=ABS(.5*(X(J)*Y(K)-Y(J)*X(K)+X(I)*(Y(J)-Y(K))+Y(I)*(X(K)-X(J))) ARE 31
      1)                            ARE 32
      MAX=MAX(0,LM(1),LM(2),LM(3),LM(4),LM(5),LM(6)) ARE 33
      MIN=MIN(0,LM(1),LM(2),LM(3),LM(4),LM(5),LM(6)) ARE 34
      MHIDTH=MAX-MIN+2            ARE 35
      IF (MHIDTH.GT.MBAND) MBAND=MHIDTH ARE 36
      IF (MHIDTH.GT.80) WRITE (6,40) MHIDTH,MH ARE 37
      IF (AREA.GT.0.0) GO TO 35    ARE 38
      WRITE (6,45) 0H             ARE 39
      RETURN                      ARE 40
C                                ARE 41
S5 XX=ZAI(1)*X(I)+ZAI(2)*X(J)+ZAI(3)*X(K) ARE 42
      YY=ZAI(1)*Y(I)+ZAI(2)*Y(J)+ZAI(3)*Y(K) ARE 43
      AREA(ND)=AREA               ARE 44
      WRITE (6,50) NN,(ZAI(I),I=1,3),AREA,XX,YY ARE 45
      RETURN                      ARE 46
C                                ARE 47
40 FORMAT (3X, 32#BANDWIDTH EXCEEDS LIMIT, MBAND= ,15,5X, 17#IN ELEMARE 48
      ENT NO. = ,15)             ARE 49
45 FORMAT (5X, 30#NEGATIVE OR ZERO AREA, ELEMENT NO.=,15) ARE 50
50 FORMAT (2X,15,5X,4E14.2,3F12.2) ARE 51
C                                ARE 52
      END                         ARE 53
      SUBROUTINE SPLINE (IMAT)     SPL 2
      COMMON /4/ MODUX(26),DELTA SPL 3
      DIMENSION XP(7), EP(11,7), SEP(11,7), PSHR(11,7), SPSNR(11,7) SPL 4
      DIMENSION PROP(319), SRD(11) SPL 5
C                                SPL 6
      SPLINE FITTING FOR TAN. MOD, TAN. POISSON RATIO VS, SIGMADCTA SPL 7
C                                SPL 8
      NP= NO. OF DATA POINTS FOR STRESS SPL 8
C                                SPL 9
      PHI= FRICTION ANGLE FOR SOIL (DEGREES) SPL 9
C                                SPL 10
      PSI= RATIO OF (SIGMA2)/(SIGMA1+SIGMA3) FOR PLANE STRAIN SPL 10
C                                SPL 11
      ANISO= DEGREE OF ANISOTROPY OF SOIL STRENGTH SPL 11
C                                SPL 12
      FOR ISOTROPY MATERIAL ANISO=1. SPL 12
C                                SPL 13
      DELTA= ANGLE OF FRICTION (DEGREES) BETWEEN SOIL AND PIPE SPL 13
C                                SPL 14
      FACTOR= STRENGTH PROPERTY CONVERSION FACTOR SPL 14
C                                SPL 15
      READ (5,55) NP,PSI,PHI,ANISO,DELTA,FACTOR SPL 16
      IF (ANISO.LE.0.0) ANISO=.10 SPL 17
      FRATIO=FAILURE/(PSI*PHI)    SPL 18
C                                SPL 19
C                                SPL 20
      XP= DCTA# ADPL NORMAL STRESS VECTOR SPL 20
C                                SPL 21
      IP= TANGENT MODULUS SPL 21
C                                SPL 22
      PSHR= TANGENT POISSONS RATIO SPL 22
C                                SPL 23
      READ (5,65) (XP(1),I=1,NP) SPL 24
      DO 5 I=1,NP                 SPL 25
5    XP(I)=FACTOR*NP(I)          SPL 26
      DO 15 ND=1,11               SPL 27
      READ (5,70) (EP(ND,J),PSHR(ND,J),J=1,NP) SPL 28
      SRD(ND)=(11.-FLDCT(ND))/10. SPL 29
      DO 10 J=1,NP                SPL 30

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10  EP(NB,J)=FACTOR*EP(NB,J)                                SPL 31
C                                     SPL 32
C      CUBIC SPLINE FITTING FOR TANGENT MODULUS AND POISSONS RATIO    SPL 33
C      .                                                                SPL 34
C          CALL SPLFIT (NP,NB,XF,EP,SEP)                        SPL 35
C          CALL SPLFIT (NP,NB,XF,PSNR,SPSNR)                    SPL 36
15  CONTINUE                                                  SPL 37
    WRITE (6,75) IMAT                                          SPL 38
    WRITE (6,80) PHI,PSI,FRACTION,DELTA,ANISO                 SPL 39
    WRITE (6,80) (XP(I),I=1,NP)                               SPL 40
    WRITE (6,85) (SRD(I),I=1,11)                               SPL 41
    DO 20 I=1,NP                                              SPL 42
20  WRITE (6,90) (EP(J,I),J=1,11)                             SPL 43
    WRITE (6,95) (SRD(I),I=1,11)                             SPL 44
    DO 25 I=1,NP                                              SPL 45
25  WRITE (6,90) (PSNR(J,I),J=1,11)                           SPL 46
C                                     SPL 47
C      STORE MATERIAL PROPERTIES ON MASS STORAGE UNIT           SPL 48
C      .                                                                SPL 49
C          PROP(1)=ANISO                                         SPL 50
C          PROP(2)=DELTA                                         SPL 51
C          PROP(3)=FRACTION                                       SPL 52
C          ND=3                                                  SPL 53
C          DO 30 I=1,7                                           SPL 54
C              ND=ND+1                                           SPL 55
30  PROP(ND)=NP(1)                                             SPL 56
    DO 35 I=1,11                                              SPL 57
    DO 35 J=1,7                                               SPL 58
    ND=ND+1                                                    SPL 59
35  PROP(ND)=EP(I,J)                                           SPL 60
    DO 40 I=1,11                                              SPL 61
    DO 40 J=1,7                                               SPL 62
    ND=ND+1                                                    SPL 63
40  PROP(ND)=SEP(I,J)                                           SPL 64
    DO 45 I=1,11                                              SPL 65
    DO 45 J=1,7                                               SPL 66
    ND=ND+1                                                    SPL 67
45  PROP(ND)=PSNR(I,J)                                          SPL 68
    DO 50 I=1,11                                              SPL 69
    DO 50 J=1,7                                               SPL 70
    ND=ND+1                                                    SPL 71
50  PROP(ND)=SPSNR(1,J)                                         SPL 72
    PROP(319)=FLOAT(NP)                                         SPL 73
    CALL WRITMS (4,PROP(319)*(MAT)                             SPL 74
    RETURN                                                    SPL 75
C                                     SPL 76
55  FORMAT (I5,5F10.0)                                         SPL 77
60  FORMAT (1X, 24HFAILURE RATIO FOR PHI = ,F6.2, 12H AND PSI = ,F5.2,SPL 78
1, 8H IS = ,F6.3/100, 8HDELTA = ,F6.2, 22H ANISOTROPY FACTOR = SPL 79
2, ,F6.2/ )                                                    SPL 80
65  FORMAT (8F10.0)                                             SPL 81
70  FORMAT (2F10.0)                                             SPL 82
75  FORMAT (/10X, 45HNON-LINEAR SOIL PROPERTIES FOR MATERIAL ND = ,I5)SPL 83
80  FORMAT (1X, 11H10MA(0CT)=,12E9,1)                         SPL 84
85  FORMAT (10X, 22HTANGENT MODULUS VALUES,/2X, 15HSTRESS RATIO = ,F3,SPL 85
11,10X,F3,1)/ )                                                SPL 86
90  FORMAT (15X, 11E9,2)                                         SPL 87
95  FORMAT (/10X, 22HTANGENT POISSON RATIO VALUES,/2X, 15HSTRESS RATIO SPL 88
10 = ,F3,1,10X,F3,1)/ )                                        SPL 89
C                                     SPL 90

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	END	SPL	91
	SUBROUTINE SPLFIT (NPN,ND,XP,YP,YDP)	SPF	2
	DIMENSION XP(7), YP(11,7), YDP(11,7), H(7), Y(7), AI(7), BI(7), CISP(7), DI(7), SDP(7)	SPF	3
C		SPF	4
C		SPF	5
C	CUBIC SPLINE FITTING	SPF	6
C		SPF	7
	NP1=NPN-1	SPF	8
	DO 5 M=1,NP1	SPF	9
5	H(M)=XP(N+1)-XP(M)	SPF	10
	SLOP1=BDX(H(1)+H(2)+YP(ND+1)+YP(ND+2)+YP(ND+3))	SPF	11
	SLOPN=BDX(H(NPN-2)+H(NPN-1)+YP(ND+NPN-2)+YP(ND+NPN-1)+YP(ND+NPN))	SPF	12
	DO 10 M=1,NPN	SPF	13
10	Y(M)=YP(ND,M)	SPF	14
	CALL COFRIT (NPN,XP,Y,SLOP1,SLOPN,AI,BI,CI,DI)	SPF	15
	CALL TRIDGNL (NPN,AI,BI,CI,DI,SDP)	SPF	16
	DO 15 I=1,NPN	SPF	17
15	YDP(ND,I)=SDP(I)	SPF	18
	RETURN	SPF	19
C		SPF	20
	END	SPF	21
	SUBROUTINE COFRIT (NPN,XP,Y,SLOP1,SLOPN,AI,BI,CI,DI)	COF	2
	DIMENSION XP(7), YP(7), AI(7), BI(7), CI(7), DI(7)	COF	3
C		COF	4
C	GENERATE SPLINE COEFFICIENTS	COF	5
C		COF	6
	AI(1)=0.0	COF	7
	BI(1)=(XP(2)-XP(1))/3.	COF	8
	CI(1)=BI(1)/2.	COF	9
	DI(1)=(YP(2)-YP(1))/(XP(2)-XP(1))-SLOP1	COF	10
	AI(NPN)=(XP(NPN)-XP(NPN-1))/6.	COF	11
	BI(NPN)=AI(NPN)*2.	COF	12
	CI(NPN)=0.0	COF	13
	DI(NPN)=-(YP(NPN)-YP(NPN-1))/(XP(NPN)-XP(NPN-1))+SLOPN	COF	14
	N1=NPN-1	COF	15
	DO 5 I=2,N1	COF	16
	AI(I)=(XP(I)-XP(I-1))/6.	COF	17
	BI(I)=(XP(I+1)-XP(I-1))/3.	COF	18
	CI(I)=(XP(I+1)-XP(I))/6.	COF	19
	DI(I)=(YP(I+1)-YP(I))/(XP(I+1)-XP(I))-(YP(I)-YP(I-1))/(XP(I)-XP(I-1))	COF	20
1	(I-1)	COF	21
5	CONTINUE	COF	22
	RETURN	COF	23
C		COF	24
	END	COF	25
	SUBROUTINE TRIDGNL (NPN,AI,BI,CI,DI,YDP)	TRI	2
	DIMENSION AI(7), BI(7), CI(7), DI(7), YDP(7), Q(10), U(10)	TRI	3
C		TRI	4
C	SOLVE TRI-DIAGONAL MATRIX	TRI	5
C		TRI	6
	P=BI(1)	TRI	7
	Q(1)=-CI(1)/P	TRI	8
	U(1)=DI(1)/P	TRI	9
	DO 5 K=2,NPN	TRI	10
	P=AI(K)*Q(K-1)+BI(K)	TRI	11
	Q(K)=-CI(K)/P	TRI	12
	U(K)=(DI(K)-AI(K)*U(K-1))/P	TRI	13
5	CONTINUE	TRI	14
	YDP(NPN)=U(NPN)	TRI	15
	N1=NPN-1	TRI	16



DO 10 L=1,N1	TRI	17
K=N1+1-L	TRI	18
YDF(K)=Q(K)*YDF(K+1)+(KE)	TRI	19
10 CONTINUE	TRI	20
RETURN	TRI	21
C	TRI	22
END	TRI	23
FUNCTION FD(S1,S2,R1,R2,R3)	FD	2
C	FD	3
C	FD	4
C	FD	5
IF (S1-S2) 5,10,5	FD	6
5 FD=(R2-R1)/S1	FD	7
RETURN	FD	8
10 FD=(-3.*R1+4.*R2-R3)/(2.*S1)	FD	9
RETURN	FD	10
C	FD	11
END	FD	12
FUNCTION BD(S1,S2,R1,R2,R3)	BD	2
C	BD	3
C	BD	4
C	BD	5
IF (S1-S2) 5,10,5	BD	6
5 BD=(R3-R2)/S2	BD	7
RETURN	BD	8
10 BD=(3.*R3-4.*R2+R1)/(2.*S1)	BD	9
RETURN	BD	10
C	BD	11
END	BD	12
FUNCTION ORDINET(H,B,C,D,E,F,P)	ORD	2
HJ=D-C	ORD	3
B1=D-F	ORD	4
B2=P-C	ORD	5
A1=B1**3	ORD	6
A2=B2**3	ORD	7
T1=A1*A/(6.*HJ)	ORD	8
T2=A2*B/(6.*HJ)	ORD	9
T3=(E-A*HJ**2/6.)*(D-P)/HJ	ORD	10
T4=(F-B*HJ**2/6.)*(P-C)/HJ	ORD	11
ORDINET=T1+T2+T3+T4	ORD	12
RETURN	ORD	13
C	ORD	14
END	ORD	15
FUNCTION FAILURE(PSI,PHI)	FR	2
C	FR	3
C	FR	4
C	FR	5
REAL MPHI	FR	6
P1=22./7.	FR	7
PHI=PHI1*P1/100.	FR	8
SINPHI=SIN(PHI)	FR	9
MPHI=(1.+SINPHI)/(1.-SINPHI)	FR	10
T1=6.*MPHI/(MPHI+1.)***2)	FR	11
T2=2.*(PSI**2-PSI+1.)	FR	12
T3=SQRT(T2-T1)	FR	13
T4=T3/(1.+PSI)	FR	14
FAILURE=T4	FR	15
RETURN	FR	16
C	FR	17
END	FR	18





	OVERLAY (R0Y,2,0)	PLT	1
C		PLT	2
	PROGRAM LAYOUT	PLT	3
	COMMON /HOBIES,HELEMT,NDUF,MBR19,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,PLT		4
	1HSTEP,NT12,ETA,NT1,NT2,NHTEHSN,IFLAG,HSIZE,NOBDE(X550),Y(X550)PLT		5
	2),JNDX(51),AMLSIS,IX(8,250),ARI(AR(250),INDX(250),INDEX(250),GAMMA(2PLT		6
	35),ZAI(3)	PLT	7
	DIMENSION XPOLY(6), YPOLY(6)	PLT	8
	CALL PLOTS	PLT	9
	READ (5,25) XMAX,YMAX,YCEN	PLT	10
	CF=10./YMAX	PLT	11
	CALL FACTOR (CF)	PLT	12
	CALL PLOT (-0.0,0.0,-3)	PLT	13
	YPOLY(4)=0.0	PLT	14
	XPOLY(4)=YPOLY(4)	PLT	15
	YPOLY(5)=1.0	PLT	16
	XPOLY(5)=YPOLY(5)	PLT	17
	CALL AXIS (-0.0,0.0,2HX,-2,XMAX,0.0,XPOLY(4),XPOLY(5),0)	PLT	18
	CALL AXIS (0.0,0.0,2HY,-2,YMAX,0.0,YPOLY(4),YPOLY(5),-1)	PLT	19
	CALL PLOT (-0.0,YMAX,3)	PLT	20
	CALL PLOT (2HAX,YMAX,2)	PLT	21
	CALL PLOT (YMAX,0.0,2)	PLT	22
	DO 20 I=1,HELEMT	PLT	23
	NT=IX(7,I)	PLT	24
	GO TO (5,10,15), NT	PLT	25
5	I1=IX(2,I)	PLT	26
	I2=IX(1,I)	PLT	27
	XPOLY(1)=X(I1)	PLT	28
	YPOLY(1)=Y(I1)	PLT	29
	XPOLY(2)=X(I2)	PLT	30
	YPOLY(2)=Y(I2)	PLT	31
	YPOLY(3)=0.0	PLT	32
	XPOLY(3)=YPOLY(3)	PLT	33
	YPOLY(4)=1.0	PLT	34
	XPOLY(4)=YPOLY(4)	PLT	35
	CALL LINE (XPOLY,YPOLY,2,1,0,0)	PLT	36
	GO TO 20	PLT	37
10	CONTINUE	PLT	38
15	I1=IX(1,I)	PLT	39
	I2=IX(2,I)	PLT	40
	I3=IX(3,I)	PLT	41
	XPOLY(4)=X(I1)	PLT	42
	XPOLY(1)=XPOLY(4)	PLT	43
	YPOLY(4)=Y(I1)	PLT	44
	YPOLY(1)=YPOLY(4)	PLT	45
	XPOLY(2)=X(I2)	PLT	46
	YPOLY(2)=Y(I2)	PLT	47
	XPOLY(3)=X(I3)	PLT	48
	YPOLY(3)=Y(I3)	PLT	49
	YPOLY(5)=0.0	PLT	50
	XPOLY(5)=YPOLY(5)	PLT	51
	YPOLY(6)=1.0	PLT	52
	XPOLY(6)=YPOLY(6)	PLT	53
	CALL LINE (XPOLY,YPOLY,4,1,0,0)	PLT	54
	XC=(X(I1)+X(I2)+X(I3))/3.-0.2	PLT	55
	YC=(Y(I1)+Y(I2)+Y(I3))/3.	PLT	56
	CALL NUMBER (XC,YC,0.4,1,0.0,2H13)	PLT	57
20	CONTINUE	PLT	58
	XC=XMAX/2.-2.	PLT	59
	YC=YMAX+2.	PLT	60



	CALL SYMBOL (0,0,YCEN,0,3,11,0,0,-1)	PLT	61
	CALL SYMBOL (XG,YC,0,6,1,INFINITE ELEMENT MESH,0,0,19)	PLT	62
	CALL PLOT (0,0,0,0,999)	PLT	63
	RETURN	PLT	64
C		PLT	65
	25 FORMAT (3F10,0)	PLT	66
C		PLT	67
	END	PLT	68
	OVERLAY(CRQV,3,0)	BLK	1
C		BLK	2
	OVERLAY(CRQV,3,0)	BLK	3
	PROGRAM BLOCK	BLK	4
	COMMON NNODE3,NELEMENT,NDOF,HBAR,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,BLK	BLK	5
	INSTEP,NT12,ETA,NT1,NT2,HITEMSH,IFLAG,NSIZE,NCODE(550),X(550),Y(550),BLK	BLK	6
	2),JNDX(51),ANLSIS,IX(8,250),AREAA(250),INDX(250),INDEX(250),GAMA(2,BLK	BLK	7
	35),ZAI(3)	BLK	8
	COMMON /1/ E,HUE,RADIUS,YCEN,YCEN,EI,KN,KS,H1,H2,INTER	BLK	9
	COMMON /3/ P	BLK	10
	COMMON /4/ NDOX(26),DELTA	BLK	11
	COMMON /5/ Q(1100),LIST(1101)	BLK	12
	DIMENSION R(1100),TEMP(17),LM(6),SK(12,12)	BLK	13
	DIMENSION KP(7),EP(11,7),SEP(11,7),PSHR(11,7),SPSHR(11,7)	BLK	14
	DIMENSION E(10),HUE(10),PROPC(319)	BLK	15
	DIMENSION A(103,103),AREAY(103)	BLK	16
	DIMENSION SR(6,6),SKUT(8,8)	BLK	17
	DIMENSION TEMP(17)	BLK	18
	REAL NUEN,NUCY	BLK	19
	REAL KN,KS	BLK	20
	REAL HUE	BLK	21
	PI=22./7.	BLK	22
	ARISD=1,0	BLK	23
	NDINC=1	BLK	24
	IF (NT3.LE.0) NDINC=0	BLK	25
	IF (NT3.LE.0) ND=ND-1	BLK	26
	NEND=3*NT3	BLK	27
	NDOF=2*ND	BLK	28
	NDOF=2*NNODE3*NT3	BLK	29
	CALL HULLMAT (A,NSIZE,NSIZE)	BLK	30
	CALL HULLMAT (SK,12,12)	BLK	31
	CALL ZERO (6,NDOF)	BLK	32
C		BLK	33
C	FIND NODAL LOADS FOR ELEMENTS IN THIS PARTICULAR LAYER	BLK	34
C		BLK	35
	DO 40 I1=1,NELEMENT	BLK	36
	NT=IX(7,I1)	BLK	37
	GD TO (40,40,5,5,5), NT	BLK	38
5	I1=IX(1,I1)	BLK	39
	I2=IX(2,I1)	BLK	40
	I3=IX(3,I1)	BLK	41
	YC=(Y(I1)+Y(I2)+Y(I3))/3.	BLK	42
	IF (XG,GT,H2,OR,YC,LE,H1) GD TO 40	BLK	43
	NT=IX(8,I1)	BLK	44
	UT=GAMA(NT)*AREAA(I1)	BLK	45
	MK=NT-2	BLK	46
	GD TO (10,20,25), MK	BLK	47
10	DO 15 I=1,6	BLK	48
15	LM(I)=2*IX(I,I1)+NT3	BLK	49
	GD TO 35	BLK	50
20	LM(1)=3*IX(1,I1)-1	BLK	51
	LM(2)=3*IX(2,I1)-1	BLK	52
	LM(3)=2*IX(3,I1)+NT3	BLK	



	LM(4)=3*IX(4, I1)-1	BLK	53
	LM(5)=2*IX(5, I1)+NT3	BLK	54
	LM(6)=2*IX(6, I1)+NT3	BLK	55
	DO 35 I=1,6	BLK	56
25	DO 30 I=1,6	BLK	57
30	LM(1)=2*IX(1, I1)+NT3	BLK	58
	LM(3)=3*IX(3, I1)-1	BLK	59
35	I1=LM(1)	BLK	60
	I2=LM(2)	BLK	61
	I3=LM(3)	BLK	62
	I4=LM(4)	BLK	63
	I5=LM(5)	BLK	64
	I6=LM(6)	BLK	65
	Q(I1)=Q(I1)-UT/12.	BLK	66
	Q(I2)=Q(I2)-UT/12.	BLK	67
	Q(I3)=Q(I3)-UT/12.	BLK	68
	Q(I4)=Q(I4)-UT/4.	BLK	69
	Q(I5)=Q(I5)-UT/4.	BLK	70
	Q(I6)=Q(I6)-UT/4.	BLK	71
40	CONTINUE	BLK	72
	DO 45 I=1,NPROP	BLK	73
45	Q(I)=Q(I)/FLDRT(NSTEP)	BLK	74
C		BLK	75
	REINHOLD 2	BLK	76
C		BLK	77
C	FORM STIFFNESS MATRIX IN BLOCKS	BLK	78
C		BLK	79
	IMAT=0	BLK	80
	KSHIFT=0	BLK	81
	HUMBLK=1	BLK	82
	NM=ND	BLK	83
	NL=1	BLK	84
	THETA=DELTA*PI/180.	BLK	85
	SLIP=TAN(THETA)	BLK	86
	SLIP=1.1*SLIP	BLK	87
50	WRITE (6,310) KSHIFT,HUMBLK,NM,NL,ND	BLK	88
	DO 290 KI=1,NLEMMT	BLK	89
	NT=IX(7,KI)	BLK	90
	NT=IX(8,KI)	BLK	91
	ENDPHL=PH	BLK	92
	ES=ES	BLK	93
	IF (NT.LE.2) GO TO 85	BLK	94
	IF (1.STOP.LE.0) GO TO 35	BLK	95
	IF (NT.NE.IMAT) GO TO 55	BLK	96
	GO TO 35	BLK	97
55	IMAT=NT	BLK	98
	CALL READHC (4,PROP,319,NT)	BLK	99
	PRO3=PROP(1)	BLK	100
	FRATIO=PROP(3)	BLK	101
	ND=3	BLK	102
	DO 60 I=1,2	BLK	103
	ND=ND+1	BLK	104
60	XP(I)=PROP(ND)	BLK	105
	DO 65 I=1,11	BLK	106
	DO 65 J=1,2	BLK	107
	ND=ND+1	BLK	108
65	EP(I,J)=PROP(ND)	BLK	109
	DO 70 I=1,11	BLK	110
	DO 70 J=1,2	BLK	111
	ND=ND+1	BLK	112



70	SEP(I,J)=PROP(MD)	BLK	113
	DO 75 I=1,11	BLK	114
	DO 75 J=1,7	BLK	115
	MD=MD+1	BLK	116
75	PSNR(I,J)=PROP(MD)	BLK	117
	DO 80 I=1,11	BLK	118
	DO 80 J=1,7	BLK	119
	MD=MD+1	BLK	120
80	SFSNR(I,J)=PROP(MD)	BLK	121
	NP=INT(PROP(319))	BLK	122
85	CONTINUE	BLK	123
C		BLK	124
C	SEARCH FOR ELEMENTS BELONG TO THIS LAYER	BLK	125
C		BLK	126
	GO TO (90,120,200,200,200), NT	BLK	127
C		BLK	128
C	TYPE I ELEMENTS	BLK	129
C		BLK	130
90	DO 95 I=1,2	BLK	131
95	LM(I)=3*(IX(I,KI)-3)	BLK	132
	DO 100 I=1,2	BLK	133
	IF (LM(I)+1,LT,NL) GO TO 190	BLK	134
	IF (LM(I)+1,LE,NM) GO TO 105	BLK	135
100	CONTINUE	BLK	136
	GO TO 290	BLK	137
105	I1=IX(1,KI)	BLK	138
	I2=IX(2,KI)	BLK	139
	CALL P100 (KI,RADIUS,EI,VCEN,X(I1),X(I2),Y(I1),Y(I2),SR)	BLK	140
C		BLK	141
C	JOIN TYPE I ELEMENTS	BLK	142
C		BLK	143
	DO 115 I=1,2	BLK	144
	DO 115 K=1,3	BLK	145
	II=LM(I)+K-KSHIFT	BLK	146
	IF (II,LE,0,OR,II,GT,ND) GO TO 115	BLK	147
	KK=3*I-2+K	BLK	148
	DO 110 J=1,2	BLK	149
	DO 110 L=1,3	BLK	150
	JJ=LM(J)+L-KSHIFT-II+1	BLK	151
	IF (JJ,LE,0) GO TO 110	BLK	152
	LL=3*J-3+L	BLK	153
	AC(JJ,II)=AC(JJ,II)+CR(KK,LL)	BLK	154
110	CONTINUE	BLK	155
115	CONTINUE	BLK	156
	GO TO 290	BLK	157
C		BLK	158
C	TYPE II ELEMENTS	BLK	159
C		BLK	160
120	DO 125 I=1,2	BLK	161
	LM(I)=3*(IX(I,KI)-3)	BLK	162
125	CONTINUE	BLK	163
	DO 130 I=3,4	BLK	164
130	LM(I)=2*(IX(I,KI)-2+NT3)	BLK	165
	DO 135 I=1,4	BLK	166
	IF (LM(I)+1,LT,NL) GO TO 135	BLK	167
	IF (LM(I)+1,LE,NM) GO TO 140	BLK	168
135	CONTINUE	BLK	169
	GO TO 290	BLK	170
140	I1=IX(1,KI)	BLK	171
	I2=IX(2,KI)	BLK	172





	EN=ENDRML	BLK	173
	YC=0.5*(Y(I1)+Y(I2))	BLK	174
	CALL READNS (1,TEMP,17,KI)	BLK	175
	CALL READNS (1,TEMP,17,KI+1)	BLK	176
	IF (INTER.LE.0) GO TO 160	BLK	177
	IF (YC.GT.H2) GO TO 160	BLK	178
	IF (YC.GT.H1.AND.HCYCLE.EQ.1) GO TO 160	BLK	179
	SIGMA=(TEMP(1)+TEMP(1))/2.	BLK	180
	TAU=(TEMP(2)+TEMP(2))/2.	BLK	181
	IF (ABS(SIGMA).LT.GAMMA(MT)) GO TO 160	BLK	182
	IF (SIGMA+GAMMA(MT)) 155,145,145	BLK	183
145	RD=TAU/SIGMA	BLK	184
	RATIO=ABS(RD)	BLK	185
	IF (RATIO.GT.SLIP) GO TO 150	BLK	186
	GO TO 160	BLK	187
150	ES=1000.0	BLK	188
	WRITE (6,320) KI	BLK	189
	GO TO 165	BLK	190
155	ES=1000.0	BLK	191
	EN=ES	BLK	192
	WRITE (6,315) KI	BLK	193
	GO TO 165	BLK	194
	ES=100.0	BLK	195
	EN=ES	BLK	196
	GO TO 165	BLK	197
160	EN=ENDRML	BLK	198
165	CALL JOINT (KI,YCEN,EN,ES,X(I1),X(I2),Y(I1),Y(I2),TH1,TH2,SKJ) BLK	199	
	IX(5,KI)=INT(TH1)	BLK	200
	IX(6,KI)=INT(TH2)	BLK	201
	TEMP(3)=EN	BLK	202
	TEMP(4)=ES	BLK	203
	CALL WRITAS (1,TEMP,17,KI)	BLK	204
C		BLK	205
C	JOINT TYPE II ELEMENT	BLK	206
C		BLK	207
	DO 175 I=1,4	BLK	208
	DO 175 K=1,2	BLK	209
	II=LM(I)+K-KSHIFT	BLK	210
	IF (II.LE.0.OR.II.GT.ND) GO TO 175	BLK	211
	KK=2*I-2*K	BLK	212
	DO 170 J=1,4	BLK	213
	DO 170 L=1,2	BLK	214
	JJ=LM(J)+L-KSHIFT-II+1	BLK	215
	LL=2*J-2*L	BLK	216
	IF (JJ.LE.0) GO TO 170	BLK	217
	ACJJ(IJ)=A(CJ,IJ)+SKJ*KK*LL)	BLK	218
170	CONTINUE	BLK	219
175	CONTINUE	BLK	220
C		BLK	221
	DO 180 I=1,2	BLK	222
180	LM(I)=3*IX(I,KI+1)-3	BLK	223
	DO 185 I=3,4	BLK	224
185	LM(I)=2*IX(I,KI+1)-2+H(I)	BLK	225
	I1=IX(1,KI+1)	BLK	226
	I2=IX(2,KI+1)	BLK	227
	CALL JOINT (KI+1,YCEN,TH,ES,X(I1),X(I2),Y(I1),Y(I2),TH1,TH2,SKJ) BLK	228	
1	T)	BLK	229
	IX(5,KI+1)=INT(TH1)	BLK	230
	IX(6,KI+1)=INT(TH2)	BLK	231
	TEMP(3)=EN	BLK	232



TEMP(4)=E3	BLK	233
CALL WRITMS (1,TEMP,17,KI+1)	BLK	234
DO 195 I=1,4	BLK	235
DO 195 K=1,2	BLK	236
II=LM(I)+K-KSHIFT	BLK	237
IF (II.LE.0.OR.II.GT.ND) GO TO 195	BLK	238
KK=2*I-2+K	BLK	239
DO 190 J=1,4	BLK	240
DO 190 L=1,2	BLK	241
JJ=LM(J)+L-KSHIFT-II+1	BLK	242
LL=2*J-2+L	BLK	243
IF (JJ.LE.0) GO TO 190	BLK	244
AA(JJ,II)=A(JJ,II)+SKKT*KK*LL	BLK	245
190 CONTINUE	BLK	246
195 CONTINUE	BLK	247
KI=KI+1	BLK	248
C	BLK	249
GO TO 290	BLK	250
C	BLK	251
C	BLK	252
C	BLK	253
TRIANGULAR ELEMENT TYPE III	BLK	254
200 NRG=NT-8	BLK	255
GO TO (205,215,225), NRG	BLK	256
205 DO 210 I=1,6	BLK	257
LM(I)=2*I*(1+KI)-2+NT3	BLK	258
GO TO 230	BLK	259
215 LM(1)=3*IX(1,KI)-3	BLK	260
LM(2)=3*IX(2,KI)-3	BLK	261
LM(3)=2*IX(3,KI)-2+NT3	BLK	262
LM(4)=3*IX(4,KI)-3	BLK	263
LM(5)=2*IX(5,KI)-2+NT3	BLK	264
LM(6)=2*IX(6,KI)-2+NT3	BLK	265
GO TO 230	BLK	266
220 DO 225 I=1,6	BLK	267
225 LM(I)=2*IX(1,KI)-2+NT3	BLK	268
LM(3)=3*IX(3,KI)-3	BLK	269
230 DO 235 I=1,6	BLK	270
IF (LM(I)+1,LT,ML) GO TO 235	BLK	271
IF (LM(I)+1,LE,NM) GO TO 240	BLK	272
235 CONTINUE	BLK	273
GO TO 290	BLK	274
240 I1=IX(1,KI)	BLK	275
I2=IX(2,KI)	BLK	276
I3=IX(3,KI)	BLK	277
VC=(Y(I1)+Y(I2)+Y(I3))/3.	BLK	278
C	BLK	279
C	BLK	280
C	BLK	281
TYPE III ELEMENT	BLK	282
IF (ISTOP.LE.0) GO TO 270	BLK	283
IF (VC,GT,H2) GO TO 265	BLK	284
IF (VC,GT,HL,AND,NCYCLE,E9,1) GO TO 270	BLK	285
CALL READMS (1,TEMP,17,KI)	BLK	286
STRESSX=ABS(TEMP(7))	BLK	287
TAUGCT=ABS(TEMP(8))	BLK	288
TAUF=STRESSX*FRATIO	BLK	289
RATIO=TAUGCT/TAUF	BLK	290
IF (RATIO,GT,1.0) WRITE (6,325) RATIO,KI	BLK	291
DO 245 LI=1,10	BLK	292
R1=FLDRT(LI-1)/10.	BLK	293
R2=FLDRT(LI)/10.	BLK	294



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                LJ=11-LI+1                                BLK 293
                IF (RATIO.GT.R1.AND.RATIO.LE.R2) GO TO 250 BLK 294
245      CONTINUE                                         BLK 295
                LJ=2                                       BLK 296
C                                                    BLK 297
C      * LJ * IS THE ET VS. SIGMA3 CURVE NO. SELECTED BASED ON STRESS RATE BLK 298
C      NOW SELECT INTERVAL OF CONFINING PRESSURE BLK 299
C                                                    BLK 300
250      IF (STRESSX.LT.XP(L1).OR.STRESSX.GT.XP(LP)) WRITE (6,330) STRESS BLK 301
1      X=KI                                               BLK 302
      DO 255 LK=2,HP                                     BLK 303
            LI=LK                                         BLK 304
            IF (STRESSX.GE.XP(LK-1).AND.STRESSX.LE.XP(LK)) GO TO 260 BLK 305
255      CONTINUE                                         BLK 306
      LI=HP                                              BLK 307
260      YDP1=SEP(LJ,LI-1)                                BLK 308
      YDPH1=SPSHR(LJ,LI-1)                                BLK 309
      YDP2=SEP(LJ,LI)                                    BLK 310
      YDPH2=SPSHR(LJ,LI)                                  BLK 311
      X1=XP(LI-1)                                         BLK 312
      X2=XP(LI)                                           BLK 313
      Y1=EP(LJ,LI-1)                                     BLK 314
      YH1=PSHR(LJ,LI-1)                                  BLK 315
      Y2=EP(LJ,LI)                                       BLK 316
      YH2=PSHR(LJ,LI)                                    BLK 317
      PP=STRESSX                                          BLK 318
      ET1=ORDINET(YDP1,YDP2,X1,X2,Y1,Y2,PP)             BLK 319
      PSH1=ORDINET(YDPH1,YDPH2,X1,X2,YH1,YH2,PP)        BLK 320
      YDP1=SEP(LJ-1,LI-1)                                BLK 321
      YDPH1=SPSHR(LJ-1,LI-1)                              BLK 322
      YDP2=SEP(LJ-1,LI)                                  BLK 323
      YDPH2=SPSHR(LJ-1,LI)                                BLK 324
      Y1=EP(LJ-1,LI-1)                                  BLK 325
      YH1=PSHR(LJ-1,LI-1)                                BLK 326
      Y2=EP(LJ-1,LI)                                    BLK 327
      YH2=PSHR(LJ-1,LI)                                  BLK 328
      ET2=ORDINET(YDP1,YDP2,X1,X2,Y1,Y2,PP)             BLK 329
      PSH2=ORDINET(YDPH1,YDPH2,X1,X2,YH1,YH2,PP)        BLK 330
      EY=ET2+(ET1-ET2)*(RATIO-R1)                       BLK 331
      NUEY=PSH2+(PSH1-PSH2)*(RATIO-R1)                  BLK 332
      EX=ANISO*EY                                         BLK 333
      NUEX=NUEY*EX/EY                                    BLK 334
      GO TO 275                                           BLK 335
265      EY=E(HT)/1000.0                                BLK 336
      EX=ANISO*EY                                         BLK 337
      NUEY=NUE(HT)                                        BLK 338
      NUEX=NUEY*EX/EY                                    BLK 339
      GO TO 275                                           BLK 340
270      EY=E(HT)                                         BLK 341
      EX=ANISO*EY                                         BLK 342
      NUEY=NUE(HT)                                        BLK 343
      NUEX=NUEY*EX/EY                                    BLK 344
275      CALL TRANGLE (KI,HT,EX,EY,NUEX,NUEY,SK)         BLK 345
      DO 285 I=1,6                                       BLK 346
      DO 285 K=1,2                                       BLK 347
            II=LK(I)+K-KSHIFT                             BLK 348
            IF (II.LE.0.OR.II.GT.ND) GO TO 285           BLK 349
            KK=I+(K-1)*6                                  BLK 350
            DO 280 J=1,6                                  BLK 351
            DO 280 L=1,2                                  BLK 352

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      JJ=LN(CJ)+NL-KSHIF F+1-11          BLK 353
      IF (CJ.LE.0) GO TO 280             BLK 354
      LL=J+(L-1)*6                      BLK 355
      A(CJ,II)=A(CJ,II)+SK(KF,LL)       BLK 356
280      CONTINUE                        BLK 357
285      CONTINUE                        BLK 358
290      CONTINUE                        BLK 359
C                                         BLK 360
C                                         BLK 361
C                                         BLK 362
C                                         BLK 363
C                                         BLK 364
C                                         BLK 365
      CALL ZERO (ARRAY,NSIZE)           BLK 366
      NX=NL-1                           BLK 367
      DO 300 N=1,NSIZE                  BLK 368
      DO 295 N=1,NSIZE                  BLK 369
295      ARRAY(N)=A(N,N)                 BLK 370
      CALL WRITMS (10,ARRAY,NSIZE,NX+N) BLK 371
300      CONTINUE                        BLK 372
      IF (NR.GE.NDOF) GO TO 305          BLK 373
      CALL NULLMAT (A,NSIZE,NSIZE)      BLK 374
      KSHIFT=KSHIFT+ND                  BLK 375
      IF (NUMBLK.EQ.1) ND=ND+NDINC       BLK 376
      NUMBLK=NUMBLK+1                   BLK 377
      NM=NM+ND                           BLK 378
      NL=NM-ND+1                         BLK 379
      GO TO 50                           BLK 380
305      IF (NT3.GT.0) ND=ND+NDINC       BLK 381
      RETURN                             BLK 382
C                                         BLK 383
310      FORMAT (5X, 9HSHIFT = ,I8,5X, 9HNUMBLK = ,I8, 9H NM = ,I5, BLK 384
      18H NL = ,I5, 7H ND = ,I5)        BLK 385
315      FORMAT (5X, 24HINTERACTION ELEMENT NO. ,I5,3X, 21HHAS FAILED IN TEBLK BLK 386
      1NSION)                             BLK 387
320      FORMAT (5X, 26HINTERACTION ELEMENT NO. = ,I5,3X, 31H HAS FAILED INBLK BLK 388
      1 EXCESSIVE SHEAR)                  BLK 389
325      FORMAT (10X, 41HSTRESS RATIO IS GREATER THAN 1 , RATIO = ,F6.2,5X,BLK 390
      1 17HIN ELEMENT NO. = ,I5)         BLK 391
330      FORMAT (10X, 56HCONFINING PRESSURE IS OUT OF RANGE OF SIGMA3, STREBLK 392
      1SSX = ,E12.2,5X, 17HIN ELEMENT NO. = ,I5) BLK 393
C                                         BLK 394
      END                                TRG 2
      SUBROUTINE TRANGLE (K,NT,CK,EY,HUEX,HUEY,SK) TRG 3
      COMMON NNODES,NELEMNT,HDOF,NBAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,TRG 4
      1NSTEP,NT12,ETA,NT1,NT2,ND,ENSN,IFLAG,NSIZE,HCODE(550),X(550),Y(550)TRG 5
      2),JNDX(51),ADUIS,IX(8,250),HRE(4,250),INDX(250),INDEX(250),GAMA(2)TRG 6
      35),ZAI(3)                           TRG 7
      COMMON /1/ E,HUE,RADIUS,X,EN,YOEN,EI,KH,KS,H1,H2,INTER TRG 8
      COMMON /2/ D                          TRG 9
      DATA PLSTRS,PLSTRN/6HPLSTR,6HPLSTRN/ TRG 10
      REAL HUEX,HUEY,HUENS                 TRG 11
      DIMENSION SK(12,12), E(10), HUE(10), D(10,10) TRG 12
      DIMENSION DI(3,3), DMAT(99)          TRG 13
      REAL KH,KS                            TRG 14
C                                         TRG 15
C      ***** TRG 16
C      GENERATE STIFFNESS MATRIX FOR TRIANGULAR ELEMENTS TRG 17
C                                         TRG 18
      AA=AREAACK)                          TRG 19
      NT=IX(8,K)                          TRG 19

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	TA=1./AA	TRG	20
C		TRG	21
C	TYPE III ELEMENT	TRG	22
C		TRG	23
	L=IX(1,K)	TRG	24
	M=IX(2,K)	TRG	25
	N=IX(3,K)	TRG	26
	X21=X(M)-X(L)	TRG	27
	X13=X(L)-X(N)	TRG	28
	X32=X(N)-X(M)	TRG	29
	Y12=Y(L)-Y(M)	TRG	30
	Y23=Y(M)-Y(N)	TRG	31
	Y31=Y(N)-Y(L)	TRG	32
	IF (ISTOP.LE.0) GO TO 5	TRG	33
	GO TO 10	TRG	34
5	D11=D(MT,1)	TRG	35
	D12=D(MT,2)	TRG	36
	D13=D(MT,3)	TRG	37
	D21=D(MT,4)	TRG	38
	D22=D(MT,5)	TRG	39
	D23=D(MT,6)	TRG	40
	D31=D(MT,7)	TRG	41
	D32=D(MT,8)	TRG	42
	D33=D(MT,9)	TRG	43
	GO TO 15	TRG	44
C		TRG	45
10	IF (AHLIS,EO,PLSTRS) CALL PLNSTRS (EX,EY,NUEX,NUYEY,DD)	TRG	46
	IF (AHLIS,EO,PLSTRN) CALL VALUES (EX,EY,NUEX,NUYEY,DD)	TRG	47
	D11=DD(1,1)	TRG	48
	D12=DD(1,2)	TRG	49
	D13=DD(1,3)	TRG	50
	D21=DD(2,1)	TRG	51
	D22=DD(2,2)	TRG	52
	D23=DD(2,3)	TRG	53
	D31=DD(3,1)	TRG	54
	D32=DD(3,2)	TRG	55
	D33=DD(3,3)	TRG	56
15	A1=D11*Y23+D13*X32	TRG	57
	A2=D31*Y23+D33*X32	TRG	58
	A3=D11*Y31+D13*X13	TRG	59
	A4=D31*Y31+D33*X13	TRG	60
	A5=D11*Y12+D13*X21	TRG	61
	A6=D31*Y12+D33*X21	TRG	62
	A7=D12*X32+D13*Y23	TRG	63
	A8=D32*X32+D33*Y23	TRG	64
	A9=D12*X13+D13*Y31	TRG	65
	A10=D32*X13+D33*Y31	TRG	66
	A11=D12*X21+D13*Y12	TRG	67
	A12=D32*X21+D33*Y12	TRG	68
C		TRG	69
	B1=D21*Y23+D23*X32	TRG	70
	B2=D21*Y31+D23*X13	TRG	71
	B3=D21*Y12+D23*X21	TRG	72
	B4=D22*X32+D23*Y23	TRG	73
	B5=D22*X13+D23*Y31	TRG	74
	B6=D22*X21+D23*Y12	TRG	75
C		TRG	76
	C11=Y23*A1+X32*A2	TRG	77
	C12=Y23*A3+X32*A4	TRG	78
	C13=Y23*A5+X32*A6	TRG	79



	C14=Y23*A7+X32*A8	TRG	80
	C15=Y23*A9+X32*A10	TRG	81
	C16=Y23*A11+X32*A12	TRG	82
C		TRG	83
	C21=Y31*A1+X13*A2	TRG	84
	C22=Y31*A3+X13*A4	TRG	85
	C23=Y31*A5+X13*A6	TRG	86
	C24=Y31*A7+X13*A8	TRG	87
	C25=Y31*A9+X13*A10	TRG	88
	C26=Y31*A11+X13*A12	TRG	89
C		TRG	90
	C31=Y12*A1+X21*A2	TRG	91
	C32=Y12*A3+X21*A4	TRG	92
	C33=Y12*A5+X21*A6	TRG	93
	C34=Y12*A7+X21*A8	TRG	94
	C35=Y12*A9+X21*A10	TRG	95
	C36=Y12*A11+X21*A12	TRG	96
C		TRG	97
	C41=X32*B1+Y23*A2	TRG	98
	C42=X32*B2+Y23*A4	TRG	99
	C43=X32*B3+Y23*A6	TRG	100
	C44=X32*B4+Y23*A8	TRG	101
	C45=X32*B5+Y23*A10	TRG	102
	C46=X32*B6+Y23*A12	TRG	103
C		TRG	104
	C51=X13*B1+Y31*A2	TRG	105
	C52=X13*B2+Y31*A4	TRG	106
	C53=X13*B3+Y31*A6	TRG	107
	C54=X13*B4+Y31*A8	TRG	108
	C55=X13*B5+Y31*A10	TRG	109
	C56=X13*B6+Y31*A12	TRG	110
C		TRG	111
	C63=X21*B3+Y12*A6	TRG	112
	C61=X21*B1+Y12*A2	TRG	113
	C62=X21*B2+Y12*A4	TRG	114
	C64=X21*B4+Y12*A8	TRG	115
	C65=X21*B5+Y12*A10	TRG	116
	C66=X21*B6+Y12*A12	TRG	117
C		TRG	118
	IF (K.GT.NT12.AND.K.LE.(NT12+N(1/2))) GO TO 20	TRG	119
	GO TO 25	TRG	120
20	ETTA=ETA/2.	TRG	121
	ETATWO=1.-2.*ETTA	TRG	122
	ETAFOUR=1.-4.*ETTA	TRG	123
	ETA2=ETATWO*ETATWO	TRG	124
	ETA4=ETAFOUR*ETAFOUR	TRG	125
	GO TO 30	TRG	126
25	ETTA=0.	TRG	127
	ETAFOUR=1.0	TRG	128
	ETATWO=ETAFOUR	TRG	129
	ETA4=1.0	TRG	130
	ETA2=ETA4	TRG	131
C		TRG	132
C		TRG	133
30	SK(1,1)=C11*TA*(1.+4.*ETTA/3.+4.*ETTA*ETTA)/(ETATWO*ETATWO*4.)	TRG	134
	SK(2,1)=-C12*TA*(12.*ETAFOUR)	TRG	135
	SK(1,2)=SK(2,1)	TRG	136
C		TRG	137
	SK(1,3)=C13*TA*(-0.393+2.*ETTA+8.*ETTA*ETTA)/(4.*ETATWO)	TRG	138
	SK(3,1)=SK(1,3)	TRG	139



	$SK(2,3)=-C23*TA/12,$	TRG	140
	$SK(3,2)=SK(2,3)$	TRG	141
	$SK(2,2)=C22*TA/(4,*ETA4)$	TRG	142
	$SK(3,3)=C33*TA*(1,+8,*ETTA/3,+16,*ETTA*ETTA)/4,$	TRG	143
C		TRG	144
	$SK(1,4)=TA*(C11*2,*ETTA+C12*(4,/3,+8,*ETTA/3,))/ (4,*ETA2*ETATHD)$	TRG	145
	$SK(4,1)=SK(1,4)$	TRG	146
	$SK(2,4)=C21*TA/(3,*ETA2*ETAFDUR)$	TRG	147
	$SK(4,2)=SK(2,4)$	TRG	148
	$SK(3,4)=4,*(C31+C32)*TA*ETTA/(3,*ETA2)$	TRG	149
	$SK(4,3)=SK(3,4)$	TRG	150
	$SK(4,4)=(2,*C11+C12+C21+2,*C22)*TA/(3,*ETA2*ETA2)$	TRG	151
C		TRG	152
	$SK(1,5)=2,*ETTA*(C11+C13)*TA/(3,*ETATHD*ETAFDUR)$	TRG	153
	$SK(5,1)=SK(1,5)$	TRG	154
	$SK(2,5)=C23*TA/(3,*ETA4)$	TRG	155
	$SK(5,2)=SK(2,5)$	TRG	156
	$SK(3,5)=(C32*(1,+4,*ETTA)+C33*4,*ETTA)*TA/(3,*ETAFDUR)$	TRG	157
	$SK(5,3)=SK(3,5)$	TRG	158
	$SK(4,5)=TA*(C12+2,*C13+C22+C23)/(3,*ETAFDUR*ETA2)$	TRG	159
	$SK(5,4)=SK(4,5)$	TRG	160
	$SK(5,5)=TA*(2,*C22+C23+C32+2,*C33)/(3,*ETA4)$	TRG	161
C		TRG	162
	$SK(1,6)=TA*(C13+2,*ETTA*(C11+C13))/(3,*ETATHD*ETAFDUR)$	TRG	163
	$SK(6,1)=SK(1,6)$	TRG	164
	$SK(2,6)=0,0$	TRG	165
	$SK(6,2)=SK(2,6)$	TRG	166
	$SK(3,6)=TA*(C31+4,*ETTA*(C31+C33))/(3,*ETAFDUR)$	TRG	167
	$SK(6,3)=SK(3,6)$	TRG	168
	$SK(4,6)=TA*(C11+C13+C21+2,*C23)/(3,*ETAFDUR*ETA2)$	TRG	169
	$SK(6,4)=SK(4,6)$	TRG	170
	$SK(5,6)=TA*(2,*C21+C23+C31+C33)/(3,*ETA4)$	TRG	171
	$SK(6,5)=SK(5,6)$	TRG	172
	$SK(6,6)=TA*(2,*C11+C13+C11+2,*C33)/(3,*ETA4)$	TRG	173
C		TRG	174
	$SK(1,7)=C14*TA*(1,+4,*ETTA/3,+4,*ETTA*ETTA)/(4,*ETA2)$	TRG	175
	$SK(7,1)=SK(1,7)$	TRG	176
	$SK(2,7)=-C24*TA/(12,*ETAFDUR)$	TRG	177
	$SK(7,2)=SK(2,7)$	TRG	178
	$SK(3,7)=-C34*TA*(1,-6,*ETTA-24,*ETTA*ETTA)/(12,*ETATHD)$	TRG	179
	$SK(7,3)=SK(3,7)$	TRG	180
	$SK(4,7)=TA*(2,*C14*ETTA+C24*(1,+2,*ETTA))/(3,*ETA2*ETATHD)$	TRG	181
	$SK(7,4)=SK(4,7)$	TRG	182
	$SK(5,7)=2,*ETTA*TA*(C24+C34)/(3,*ETATHD*(1,+2,*ETTA))$	TRG	183
	$SK(7,5)=SK(5,7)$	TRG	184
	$SK(6,7)=TA*(2,*C14*ETTA+C34*(1,+2,*ETTA))/(3,*ETATHD*ETAFDUR)$	TRG	185
	$SK(7,6)=SK(6,7)$	TRG	186
C		TRG	187
	$SK(7,7)=TA*(C44*(1,+4,*ETTA/3,+4,*ETTA*ETTA)/(4,*ETA2)$	TRG	188
		TRG	189
	$SK(1,8)=TA*(C15*(-1,+2,*ETTA))/(12,*ETAFDUR*ETATHD)$	TRG	190
	$SK(8,1)=SK(1,8)$	TRG	191
	$SK(2,8)=TA*(C25/(4,*ETA4)$	TRG	192
	$SK(8,2)=SK(2,8)$	TRG	193
	$SK(3,8)=-C35*TA/12,$	TRG	194
	$SK(8,3)=SK(3,8)$	TRG	195
	$SK(4,8)=C15*TA/(3,*ETAFDUR*ETA2)$	TRG	196
	$SK(8,4)=SK(4,8)$	TRG	197
	$SK(5,8)=C35*TA/(3,*ETA4)$	TRG	198
	$SK(8,5)=SK(5,8)$	TRG	199
	$SK(6,8)=0,0$	TRG	199



	$SK(8,6)=SK(6,8)$	TRG	200
	$SK(7,8)=-C45*TA/(12,*ETAFDUR)$	TRG	201
	$SK(8,7)=SK(7,8)$	TRG	202
	$SK(8,8)=C55*TA/(4,*ETA4)$	TRG	203
C		TRG	204
	$SK(1,9)=-C16*TA*(1,-2,*ETTA-8,*ETTA*ETTA)/(12,*ETATWD)$	TRG	205
	$SK(9,1)=SK(1,9)$	TRG	206
	$SK(2,9)=-C26*TA/12,$	TRG	207
	$SK(9,2)=SK(2,9)$	TRG	208
	$SK(3,9)=C36*TA*(1,+8,*ETTA/3,+16,*ETTA*ETTA)/4,$	TRG	209
	$SK(9,3)=SK(3,9)$	TRG	210
	$SK(4,9)=4,*ETTA*TA*(C16+C26)/(3,*ETA2)$	TRG	211
	$SK(9,4)=SK(4,9)$	TRG	212
	$SK(5,9)=TA*(C26*(1,+4,*ETTA)+C36*4,*ETTA)/(3,*ETAFDUR)$	TRG	213
	$SK(9,5)=SK(5,9)$	TRG	214
	$SK(6,9)=TA*(C16*(1,+4,*ETTA)+C36*4,*ETTA)/(3,*ETAFDUR)$	TRG	215
	$SK(9,6)=SK(6,9)$	TRG	216
	$SK(7,9)=-TA*C46*(1,-6,*ETTA-24,*ETTA*ETTA)/(12,*ETATWD)$	TRG	217
	$SK(9,7)=SK(7,9)$	TRG	218
	$SK(8,9)=-C56*TA/12,$	TRG	219
	$SK(9,8)=SK(8,9)$	TRG	220
	$SK(9,9)=C66*TA*(1,+8,*ETTA/3,+16,*ETTA*ETTA)/4,$	TRG	221
C		TRG	222
	$SK(1,10)=TA*(C14*2,*ETTA+C15*(1,+2,*ETTA))/(3,*ETATWD*ETA2)$	TRG	223
	$SK(10,1)=SK(1,10)$	TRG	224
	$SK(2,10)=C24*TA/(3,*ETAFDUR*ETA2)$	TRG	225
	$SK(10,2)=SK(2,10)$	TRG	226
	$SK(3,10)=4,*TA*ETTA*(C34+C35)/(3,*ETA2)$	TRG	227
	$SK(10,3)=SK(3,10)$	TRG	228
	$SK(4,10)=TA*(2,*C14+C15+C24+2,*C25)/(3,*ETA2*ETA2)$	TRG	229
	$SK(10,4)=SK(4,10)$	TRG	230
	$SK(5,10)=TA*(C24+C25+2,*C34+C35)/(3,*ETAFDUR*ETA2)$	TRG	231
	$SK(10,5)=SK(5,10)$	TRG	232
	$SK(6,10)=TA*(C14+C15+C34+2,*C35)/(3,*ETA2*ETAFDUR)$	TRG	233
	$SK(10,6)=SK(6,10)$	TRG	234
	$SK(7,10)=TA*(2,*ETTA*C44+C45*(1,+2,*ETTA))/(3,*ETA2*ETATWD)$	TRG	235
	$SK(10,7)=SK(7,10)$	TRG	236
	$SK(8,10)=C54*TA/(3,*ETAFDUR*ETA2)$	TRG	237
	$SK(10,8)=SK(8,10)$	TRG	238
	$SK(9,10)=4,*ETTA*TA*(C64+C65)/(3,*ETA2)$	TRG	239
	$SK(10,9)=SK(9,10)$	TRG	240
	$SK(10,10)=TA*(2,*C44+C45+C54+2,*C55)/(3,*ETA4*ETA4)$	TRG	241
C		TRG	242
	$SK(1,11)=2,*ETTA*TA*(C15+C16)/(3,*ETATWD*ETAFDUR)$	TRG	243
	$SK(11,1)=SK(1,11)$	TRG	244
	$SK(2,11)=C26*TA/(3,*ETA4)$	TRG	245
	$SK(11,2)=SK(2,11)$	TRG	246
	$SK(3,11)=TA*(C35*(1,+4,*ETTA)+4,*ETTA*C36)/(3,*ETAFDUR)$	TRG	247
	$SK(11,3)=SK(3,11)$	TRG	248
	$SK(4,11)=TA*(C15+2,*C16+C25+C26)/(3,*ETAFDUR*ETA2)$	TRG	249
	$SK(11,4)=SK(4,11)$	TRG	250
	$SK(5,11)=TA*(2,*C25+C26+C35+2,*C36)/(3,*ETA4)$	TRG	251
	$SK(11,5)=SK(5,11)$	TRG	252
	$SK(6,11)=TA*(2,*C15+C16+C35+C36)/(3,*ETA4)$	TRG	253
	$SK(11,6)=SK(6,11)$	TRG	254
	$SK(7,11)=TA*2,*ETTA*(C45+C46)/(3,*ETATWD*ETAFDUR)$	TRG	255
	$SK(11,7)=SK(7,11)$	TRG	256
	$SK(8,11)=TA*C56/(3,*ETA4)$	TRG	257
	$SK(11,8)=SK(8,11)$	TRG	258
	$SK(9,11)=TA*(C65*(1,+4,*ETTA)+4,*ETTA*C66)/(3,*ETAFDUR)$	TRG	259





	SK(11,9)=SK(9,11)	TRG	260
	SK(10,11)=TA*(C45+2.*C46+C55+C56)/(3.*ETAFOUR*ETA2)	TRG	261
	SK(11,10)=SK(10,11)	TRG	262
	SK(11,11)=TA*(2.*C55+C56+C65+2.*C66)/(3.*ETA4)	TRG	263
C		TRG	264
	SK(1,12)=TA*(C14*2.*ETTA+C16*(1.+2.*ETTA))/(3.*ETATWO)	TRG	265
	SK(12,1)=SK(1,12)	TRG	266
	SK(2,12)=0,0	TRG	267
	SK(12,2)=SK(2,12)	TRG	268
	SK(3,12)=TA*(C34*(1.+4.*ETTA)+C36*4.*ETTA)/(3.*ETAFOUR)	TRG	269
	SK(12,3)=SK(3,12)	TRG	270
	SK(4,12)=TA*(C14+C16+C24+2.*C26)/(3.*ETAFOUR*ETA2)	TRG	271
	SK(12,4)=SK(4,12)	TRG	272
	SK(5,12)=TA*(2.*C24+C26+(C34+C36))/(3.*ETA4)	TRG	273
	SK(12,5)=SK(5,12)	TRG	274
	SK(6,12)=TA*(2.*C14+C16+(C34+2.*C36))/(3.*ETA4)	TRG	275
	SK(12,6)=SK(6,12)	TRG	276
	SK(7,12)=TA*(2.*ETTA*C44+(1.+2.*ETTA)*C46)/(3.*ETATWO*ETAFOUR)	TRG	277
	SK(12,7)=SK(7,12)	TRG	278
	SK(8,12)=0,0	TRG	279
	SK(12,8)=SK(8,12)	TRG	280
	SK(9,12)=TA*(C64*(1.+4.*ETTA)+C66*4.*ETTA)/(3.*ETAFOUR)	TRG	281
	SK(12,9)=SK(9,12)	TRG	282
	SK(10,12)=TA*(C44+C46+C54+2.*C56)/(3.*ETAFOUR*ETA2)	TRG	283
	SK(12,10)=SK(10,12)	TRG	284
	SK(11,12)=TA*(2.*C54+C56+C64+C66)/(3.*ETA4)	TRG	285
	SK(12,11)=SK(11,12)	TRG	286
	SK(12,12)=TA*(2.*C44+C46+C64+2.*C66)/(3.*ETA4)	TRG	287
C		TRG	288
C		TRG	289
	ND=0	TRG	290
	DO 45 I=1,3	TRG	291
	DO 45 J=1,3	TRG	292
	ND=ND+1	TRG	293
	IF (151DP) 35,35,40	TRG	294
35	DNAT(MD)=0,NT,ND	TRG	295
	GO TO 45	TRG	296
40	DNAT(MD)=DD(I,J)	TRG	297
45	CONTINUE	TRG	298
	DNAT(10)=NUEY	TRG	299
	DNAT(11)=NUEY	TRG	300
	ND=11	TRG	301
	DO 55 I=1,10	TRG	302
	DO 50 J=1,12	TRG	303
	ND=ND+1	TRG	304
50	DNAT(MD)=SK(I,J)	TRG	305
55	CONTINUE	TRG	306
	CALL URTIMS (3, DNAT, 89, K)	TRG	307
	RETURN	TRG	308
C		TRG	309
	END	TRG	310
	SUBROUTINE DNMULTY (A,B,C,M,N)	MAT	2
	DIMENSION A(M,N), B(N,N), C(M,N)	MAT	3
C		MAT	4
C	MATRIX * A * I2 MULTIPLIED WITH * B * AND STORED IN * C *	MAT	5
C		MAT	6
	DO 10 I=1,M	MAT	7
	DO 10 J=1,N	MAT	8
	SUM=0,0	MAT	9
	DO 5 K=1,N	MAT	10



5	SUM=SUM+A(I,K)*B(K,J)	MAT	11
10	C(I,J)=SUM	MAT	12
	RETURN	MAT	13
C		MAT	14
	ENTRY MATRBL	MAT	15
C		MAT	16
C	TRANSPOSE OF * A * IS MULTIPLIED WITH * B * AND STORED INTO * C *	MAT	17
C		MAT	18
	DO 20 I=1,M	MAT	19
	DO 20 J=1,N	MAT	20
	SUM=0.0	MAT	21
	DO 15 K=1,H	MAT	22
15	SUM=SUM+A(K,I)*B(K,J)	MAT	23
20	C(I,J)=SUM	MAT	24
	RETURN	MAT	25
C		MAT	26
	END	MAT	27
	SUBROUTINE VALUES (EX,EY,HUEX,HUEY,DD)	VLU	2
C		VLU	3
C	CALCULATE = DD = MATRIX FOR PLANE STRAIN SITUATION	VLU	4
C		VLU	5
	DIMENSION DD(3,3)	VLU	6
	REAL HUEX,HUEY	VLU	7
	RH=EX/EY	VLU	8
	RH=0.5/(1.+HUEY)	VLU	9
	C=EY/(C1.+HUEX)*(C1.-HUEX-2.*RH*HUEY*HUEY)	VLU	10
	DD(1,1)=C*RH*(C1.-RH*HUEY*HUEY)	VLU	11
	DD(2,1)=C*RH*(C1.+HUEX)*HUEY	VLU	12
	DD(1,2)=DD(2,1)	VLU	13
	DD(2,2)=C*(1.-HUEX*HUEX)	VLU	14
	DD(3,3)=C*RH*(C1.+HUEX)*(C1.-HUEX-2.*RH*HUEY*HUEY)	VLU	15
	DD(3,2)=0.0	VLU	16
	DD(3,1)=DD(3,2)	VLU	17
	DD(2,3)=DD(3,1)	VLU	18
	DD(1,3)=DD(2,3)	VLU	19
	RETURN	VLU	20
C		VLU	21
	END	VLU	22
	SUBROUTINE PLHSTRS (EX,EY,HUEX,HUEY,DD)	PLS	2
C		PLS	3
C	CALCULATE = DD = MATRIX FOR PLANE STRESS SITUATION	PLS	4
C		PLS	5
	DIMENSION DD(3,3)	PLS	6
	REAL HUEX,HUEY	PLS	7
	RH=EX/EY	PLS	8
	RH=0.5/(1.+HUEY)	PLS	9
	C=EY/(C1.-RH*HUEY*HUEY)	PLS	10
	DD(1,1)=C*RH	PLS	11
	DD(2,1)=C*RH*HUEY	PLS	12
	DD(1,2)=DD(2,1)	PLS	13
	DD(2,2)=C	PLS	14
	DD(3,3)=C*RH*(C1.-RH*HUEY*HUEY)	PLS	15
	DD(3,2)=0.0	PLS	16
	DD(3,1)=DD(3,2)	PLS	17
	DD(2,3)=DD(3,1)	PLS	18
	DD(1,3)=DD(2,3)	PLS	19
	RETURN	PLS	20
C		PLS	21
	END	PLS	22
	FUNCTION ORDINET(A,B,C,D,E,F,P)	ORD	2



C		ORD	3
C	DETERMINE TANGENT MODULUS USING SPLINE FUNCTION	ORD	4
C		ORD	5
	HJ=D-C	ORD	6
	B1=D-P	ORD	7
	B2=P-C	ORD	8
	A1=B1*B1*B1	ORD	9
	A2=B2*B2*B2	ORD	10
	T1=A1*A/(6.*HJ)	ORD	11
	T2=A2*B/(6.*HJ)	ORD	12
	T3=(E-A*HJ*HJ/6.)*(D-P)/HJ	ORD	13
	T4=(F-B*HJ*HJ/6.)*(P-C)/HJ	ORD	14
	ORDINET=T1+T2+T3+T4	ORD	15
	RETURN	ORD	16
C		ORD	17
	END	ORD	18
	SUBROUTINE RING (KI,R,EI,YCEN,X1,X2,Y1,Y2,SK)	RNG	2
	DIMENSION SR(6,6), SK(6,6)	RNG	3
	DIMENSION TL(6,6), TC(6,6)	RNG	4
	DIMENSION THP(36)	RNG	5
	REAL RUE	RNG	6
C		RNG	7
C	STIFFNESS MATRIX FOR RING ELEMENTS	RNG	8
C		RNG	9
	SPRH=SQRT((X1-X2)**2+(Y1-Y2)**2)	RNG	10
	BETA=SPRH/R	RNG	11
	BETA2=2.*BETA	RNG	12
	SH=SIN(BETA)	RNG	13
	CS=COS(BETA)	RNG	14
	SH2=SIN(BETA2)	RNG	15
	A=BETA-SH	RNG	16
	B=CS+SH*SH/2.-1.	RNG	17
	C=1.5*BETA-2.*SH+SH2/4.	RNG	18
	D=0.5*BETA-SH2/4.	RNG	19
	E=CS-1.	RNG	20
	AA=E*BETA-D	RNG	21
	BB=B-A*BETA	RNG	22
	CC=A*D-B*B	RNG	23
	DD=A*A/BETA-C	RNG	24
	EE=C*B-A*B	RNG	25
	FF=B*B-C*D	RNG	26
	G=B*(B-2.*A*B/BETA)+C*(E*B/BETA-D)+A*A*B/BETA	RNG	27
	FT=E1/(R**3)*G	RNG	28
	SR(1,1)=FT*AA	RNG	29
	SR(1,2)=FT*BB	RNG	30
	SR(2,1)=SR(1,2)	RNG	31
	SR(1,3)=FT*CC*R/BETA	RNG	32
	SR(3,1)=SR(1,3)	RNG	33
	SR(2,2)=FT*DD	RNG	34
	SR(2,3)=FT*EE*R/BETA	RNG	35
	SR(3,2)=SR(2,3)	RNG	36
	SR(3,3)=FT*FF*R/BETA	RNG	37
	SR(4,1)=-FT*(AA*CS+BB*SN)	RNG	38
	SR(1,4)=SR(4,1)	RNG	39
	SR(4,2)=-FT*(BB*CS+DD*SN)	RNG	40
	SR(2,4)=SR(4,2)	RNG	41
	SR(4,3)=-FT*(CC*CS+EE*SN)*R/BETA	RNG	42
	SR(3,4)=SR(4,3)	RNG	43
	SR(1,5)=FT*(AA*SN-BB*CS)	RNG	44
	SR(5,1)=SR(1,5)	RNG	45



	SR(5,2)=FT*(BB*SH-DD*CS)	RNG	46
	SR(2,5)=SR(5,2)	RNG	47
	SR(5,3)=FT*(DD*SH-EE*CS)*R/BETA	RNG	48
	SR(3,5)=SR(5,3)	RNG	49
	SR(6,1)=FT*(AA*(CS-1.))+BL*SH-DD/BETA)*R	RNG	50
	SR(1,6)=SR(6,1)	RNG	51
	SR(6,2)=FT*(BB*(CS-1.))+DI*SH-EE/BETA)*R	RNG	52
	SR(2,6)=SR(6,2)	RNG	53
	SR(6,3)=FT*(DD*(CS-1.))+EL*SH-FF)*R*R/BETA	RNG	54
	SR(3,6)=SR(6,3)	RNG	55
	SR(4,4)=SR(1,1)	RNG	56
	SR(4,5)=-SR(1,2)	RNG	57
	SR(5,4)=SR(4,5)	RNG	58
	SR(4,6)=SR(1,3)	RNG	59
	SR(6,4)=SR(4,6)	RNG	60
	SR(5,5)=SR(2,2)	RNG	61
	SR(5,6)=-SR(2,3)	RNG	62
	SR(6,5)=SR(5,6)	RNG	63
	SR(6,6)=SR(3,3)	RNG	64
C		RNG	65
C	TRANSFORMATION OF COORDINATE SYSTEM	RNG	66
C		RNG	67
	CALL HULLMAT (TL,6,6)	RNG	68
	CALL HULLMAT (TC,6,6)	RNG	69
	T1=Y1-YCEN	RNG	70
	T2=Y2-YCEN	RNG	71
	IF (X1.EQ.0.0) X1=0.00001	RNG	72
	IF (X2.EQ.0.0) X2=0.00001	RNG	73
	TH1=T1/X1	RNG	74
	TH2=T2/X2	RNG	75
	PHI1=ATAN(TH1)	RNG	76
	PHI2=ATAN(TH2)	RNG	77
	CS1=COS(PHI1)	RNG	78
	SH1=SIN(PHI1)	RNG	79
	CS2=COS(PHI2)	RNG	80
	SH2=SIN(PHI2)	RNG	81
	TL(1,1)=-SH1	RNG	82
	TL(1,2)=+CS1	RNG	83
	TL(2,1)=-CS1	RNG	84
	TL(2,2)=-SH1	RNG	85
	TL(4,4)=-SH2	RNG	86
	TL(4,5)=+CS2	RNG	87
	TL(5,4)=-CS2	RNG	88
	TL(5,5)=-SH2	RNG	89
	TL(6,6)=1.0	RNG	90
	TL(3,3)=TL(6,6)	RNG	91
	CALL MATMULT (SR,TL,TC,6,6)	RNG	92
	CALL MATRMUL (TL,TC,SK,6,6)	RNG	93
	MD=0	RNG	94
	DO 5 I=1,6	RNG	95
	DO 5 J=1,6	RNG	96
	MD=MD+1	RNG	97
	TMP(MD)=SK(I,J)	RNG	98
5	CONTINUE	RNG	99
	CALL WRITMS (7,TMP,MD,KI)	RNG	100
	RETURN	RNG	101
C		RNG	102
	END	RNG	103
	SUBROUTINE JOINT (KI,YCEN,EN,ES,X1,X2,Y1,Y2,TH1,TH2,SKJT)	JHT	2
	DIMENSION SKJT(8,8), TL(8,8), TL(8,8), TMP(64)	JHT	3





	EQUIVALENCE (TC(1,1),TMP(1))	JNT	4
C		JNT	5
C	STIFFNESS MATRIX FOR INTERACTION ELEMEN	JNT	6
C		JNT	7
	PI=22./7.	JNT	8
	SPAN=SQRT((X1-X2)**2+(Y1-Y2)**2)	JNT	9
	T1=Y1-YCEN	JNT	10
	T2=Y2-YCEN	JNT	11
	T1=-T1	JNT	12
	T2=-T2	JNT	13
	IF (T1.EQ.0.0) T1=0.00001	JNT	14
	IF (T2.EQ.0.0) T1=0.00001	JNT	15
	TH1=ABS(X1/T1)	JNT	16
	TH2=ABS(X2/T2)	JNT	17
	THETA1=ATAN(TH1)	JNT	18
	THETA2=ATAN(TH2)	JNT	19
	IF (T1.LT.0.0) THETA1=22./7.-THETA1	JNT	20
	IF (T2.LT.0.0) THETA2=22./7.-THETA2	JNT	21
	TH1=10.*(THETA1*180./PI)	JNT	22
	TH2=10.*(THETA2*180./PI)	JNT	23
	CALL HULLMAT (SKJT,8,8)	JNT	24
	CS=SPAN*ES/6.	JNT	25
	CN=SPAN*CN/6.	JNT	26
	SKJT(1,1)=2.*CS	JNT	27
	SKJT(1,3)=CS	JNT	28
	SKJT(1,5)=-CS	JNT	29
	SKJT(1,7)=-2.*CS	JNT	30
	SKJT(2,2)=2.*CN	JNT	31
	SKJT(2,4)=CN	JNT	32
	SKJT(2,6)=-CN	JNT	33
	SKJT(2,8)=-2.*CN	JNT	34
	SKJT(3,1)=CS	JNT	35
	SKJT(3,3)=2.*CS	JNT	36
	SKJT(3,5)=-2.*CS	JNT	37
	SKJT(3,7)=-CS	JNT	38
	SKJT(4,2)=CN	JNT	39
	SKJT(4,4)=2.*CN	JNT	40
	SKJT(4,6)=-2.*CN	JNT	41
	SKJT(4,8)=-CN	JNT	42
	SKJT(5,1)=-CS	JNT	43
	SKJT(5,3)=-2.*CS	JNT	44
	SKJT(5,5)=2.*CS	JNT	45
	SKJT(5,7)=CS	JNT	46
	SKJT(6,2)=-CN	JNT	47
	SKJT(6,4)=-2.*CN	JNT	48
	SKJT(6,6)=2.*CN	JNT	49
	SKJT(6,8)=CN	JNT	50
	SKJT(7,1)=-2.*CS	JNT	51
	SKJT(7,3)=-CS	JNT	52
	SKJT(7,5)=CS	JNT	53
	SKJT(7,7)=2.*CS	JNT	54
	SKJT(8,2)=-2.*CN	JNT	55
	SKJT(8,4)=-CN	JNT	56
	SKJT(8,6)=CN	JNT	57
	SKJT(8,8)=2.*CN	JNT	58
	CALL HULLMAT (TL,8,8)	JNT	59
	CALL HULLMAT (TC,8,8)	JNT	60
	CS1=COS(THETA1)	JNT	61
	SH1=SIN(THETA1)	JNT	62
	CS2=COS(THETA2)	JNT	63



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SN2=SIN(THETA2)                                JNT 64
TL(7,7)=CS1                                     JNT 65
TL(1,1)=TL(7,7)                                JNT 66
TL(7,8)=SN1                                     JNT 67
TL(1,2)=TL(7,8)                                JNT 68
TL(8,7)=-SN1                                    JNT 69
TL(2,1)=TL(8,7)                                JNT 70
TL(8,8)=CS1                                     JNT 71
TL(2,2)=TL(8,8)                                JNT 72
TL(5,5)=CS2                                     JNT 73
TL(3,3)=TL(5,5)                                JNT 74
TL(5,6)=SN2                                     JNT 75
TL(3,4)=TL(5,6)                                JNT 76
TL(6,5)=-SN2                                    JNT 77
TL(4,3)=TL(6,5)                                JNT 78
TL(6,6)=CS2                                     JNT 79
TL(4,4)=TL(6,6)                                JNT 80
CALL MATRMUL (SKUT,TL,TC,8,8)                   JNT 81
CALL MATRMUL (TL,TC,SKUT,8,8)                   JNT 82
MD=0                                             JNT 83
DO 5 I=1,8                                       JNT 84
DO 5 J=1,8                                       JNT 85
    MD=MD+1                                     JNT 86
    TMP(MD)=SKUT(I,J)                         JNT 87
5 CONTINUE                                       JNT 88
CALL WRITMS (7,TMP,MD,K1)                       JNT 89
RETURN                                           JNT 90
C                                                JNT 91
END                                              JNT 92
OVERLAY(RDY,4,0)                                STR 1
C OVERLAY(RDY,4,0)                                STR 2
PROGRAM STRESS                                  STR 3
COMMON /NODE/ NLEMMNT,NDOF,NBAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,STR 4
1 NSTEP,NT12,ETA,NT1,NT2,NDIENH,IFLAG,NSIZE,HCODE(550),X(550),Y(550)STR 5
2),JNDX(51),ANLSIS,IX(8,250),ARENA(250),INDX(250),INDEX(250),GAMA(2STR 6
35),ZAI(3)                                     STR 7
COMMON /1/ E,HUE,RADIUS,XGEN,YGEN,ET,KN,KS,H1,H2,INTER STR 8
COMMON /2/ D                                     STR 9
COMMON /3/ R                                     STR 10
COMMON /4/ RU90(26),DELTA                       STR 11
COMMON /5/ O(1100),LIST(110)                   STR 12
REAL HUE1,HUE2,HUE,HUEK,KO,KH                  STR 13
DIMENSION TEMP(17), R(1100), E(10), HUE(10), D(10,10) STR 14
DIMENSION DMNT(90), UC(12), SKUT(12,12), PP(12), TEMP(17) STR 15
DIMENSION Ix(50,4), FR(2)                       STR 16
C                                                STR 17
C *****STR 18
C THIS ROUTINE COMPUTES STRESS, STRAIN, OCTAHEDRAL STRESSES AND STR 19
C STRAINS FROM COMPUTED NODAL DISPLACEMENTS STORED AS R(I) ON TAPE STR 20
C *****STR 21
C *****STR 22
C PI=22./7.                                     STR 23
CALL ZERO (0,NDOF)                             STR 24
IFLAG=0                                          STR 25
THETA=DELTA*PI/180.                            STR 26
SLIP=TAN(THETA)                                STR 27
SLIP=1.1*SLIP                                  STR 28
C                                                STR 29
DO 100 KEL=1,NLEMMNT                           STR 30

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	ITYP=IX(7,KEL)	STR	32
	MT=IX(8,KEL)	STR	33
	GO TO (100,5,35,35,35), ITYP	STR	34
C		STR	35
C	TYPE II INTERACTION ELEMENT	STR	36
C		STR	37
5	CALL ZERO (0,12)	STR	38
	DO 10 I=1,2	STR	39
	DO 10 J=1,2	STR	40
	K=(I-1)*2+J	STR	41
	H=3*IX(I,KEL)-3+J	STR	42
	IA(KEL,I)=H	STR	43
	U(K)=R(H)	STR	44
10	CONTINUE	STR	45
	DO 15 I=3,4	STR	46
	DO 15 J=1,2	STR	47
	K=(I-1)*2+J	STR	48
	H=2*IX(I,KEL)-2+HTO+J	STR	49
	IA(KEL,I)=H	STR	50
	U(K)=R(H)	STR	51
15	CONTINUE	STR	52
	I=IX(1,KEL)	STR	53
	J=IX(2,KEL)	STR	54
	SPAN=SQRT((X(I)-X(J))*2+(Y(I)-Y(J))*2)	STR	55
	TH1=FLDHT(I,X(5,KEL))	STR	56
	TH2=FLDHT(I,X(6,KEL))	STR	57
	THETA1=TH1*PI/1800.	STR	58
	THETA2=TH2*PI/1800.	STR	59
	CS1=COS(THETA1)	STR	60
	SH1=SIN(THETA1)	STR	61
	CS2=COS(THETA2)	STR	62
	SH2=SIN(THETA2)	STR	63
	CALL ZERO (FP,12)	STR	64
	CALL NULFAT (SKUT,12,12)	STR	65
	SKUT(7,7)=CS1	STR	66
	SKUT(1,1)=SKUT(7,7)	STR	67
	SKUT(7,8)=SH1	STR	68
	SKUT(1,2)=SKUT(7,8)	STR	69
	SKUT(8,7)=-SH1	STR	70
	SKUT(2,1)=SKUT(8,7)	STR	71
	SKUT(8,8)=CS1	STR	72
	SKUT(2,2)=SKUT(8,8)	STR	73
	SKUT(5,5)=CS2	STR	74
	SKUT(3,3)=SKUT(5,5)	STR	75
	SKUT(5,6)=SH2	STR	76
	SKUT(3,4)=SKUT(5,6)	STR	77
	SKUT(6,5)=-SH2	STR	78
	SKUT(4,3)=SKUT(6,5)	STR	79
	SKUT(6,6)=CS2	STR	80
	SKUT(4,4)=SKUT(6,6)	STR	81
	DO 25 I=1,8	STR	82
	SUM=0.0	STR	83
	DO 20 K=1,8	STR	84
20	SUM=SUM+SKUT(I,K)*U(K)	STR	85
	PP(I)=SUM	STR	86
25	CONTINUE	STR	87
	T1=-PP(1)-PP(3)+PP(5)+PP(7)	STR	88
	T2=-PP(2)-PP(4)+PP(6)+PP(8)	STR	89
	CALL READBS (1+TEMP,17,KEL)	STR	90
	FINN=TEMP(1)	STR	91



	FIXS=TEMP(2)	STR	92
	EN=TEMP(3)	STR	93
	ES=TEMP(4)	STR	94
	PH=0.5*I2*EN/SPAN	STR	95
	PS=0.5*I1*ES/SPAN	STR	96
	TEMP(1)=TEMP(1)+PH	STR	97
	TEMP(2)=TEMP(2)+PS	STR	98
	DO 30 K=5,I2	STR	99
30	TEMP(K)=U(K-4)	STR	100
	TEMP(13)=PS	STR	101
	TEMP(14)=PH	STR	102
	TEMP(15)=FIXS	STR	103
	TEMP(16)=FINH	STR	104
	CALL WRITMS (1,TEMP,17,KEL)	STR	105
	GO TO 100	STR	106
C		STR	107
C		STR	108
C	TYPE III ELEMENT	STR	109
C		STR	110
35	I=IX(1,KEL)	STR	111
	J=IX(2,KEL)	STR	112
	KK=IX(3,KEL)	STR	113
	L=IX(4,KEL)	STR	114
	M=IX(5,KEL)	STR	115
	N=IX(6,KEL)	STR	116
	MK=ITYP-2	STR	117
	GO TO (40,45,50), MK	STR	118
40	I1=2*I-1+NT3	STR	119
	I2=2*J-1+NT3	STR	120
	I3=2*KK-1+NT3	STR	121
	I4=2*L-1+NT3	STR	122
	I5=2*M-1+NT3	STR	123
	I6=2*N-1+NT3	STR	124
	GO TO 55	STR	125
45	I1=3*I-2	STR	126
	I2=3*J-2	STR	127
	I3=2*KK-1+NT3	STR	128
	I4=3*L-2	STR	129
	I5=2*M-1+NT3	STR	130
	I6=2*N-1+NT3	STR	131
	GO TO 55	STR	132
50	I1=2*I-1+NT3	STR	133
	I2=2*J-1+NT3	STR	134
	I3=3*KK-2	STR	135
	I4=2*L-1+NT3	STR	136
	I5=2*M-1+NT3	STR	137
	I6=2*N-1+NT3	STR	138
55	CONTINUE	STR	139
	AA=AREA*(KEL)	STR	140
	YC=(Y(I)+Y(J)+Y(KK))/3.	STR	141
	IF (YC,GT,H2) GO TO 100	STR	142
	CALL REHAMS (3,DMAT,8,KEL)	STR	143
	D11=DMAT(1)	STR	144
	D12=DMAT(2)	STR	145
	D13=DMAT(3)	STR	146
	D21=DMAT(4)	STR	147
	D22=DMAT(5)	STR	148
	D23=DMAT(6)	STR	149
	D31=DMAT(7)	STR	150
	D32=DMAT(8)	STR	151





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D33=DMAT(9) STR 152
HUE1=DMAT(10) STR 153
HUE2=DMAT(11) STR 154
X21=X(J)-X(I) STR 155
X13=X(I)-X(KK) STR 156
X32=X(KK)-X(J) STR 157
Y23=Y(J)-Y(KK) STR 158
Y31=Y(KK)-Y(I) STR 159
Y12=Y(I)-Y(J) STR 160
U1=R(I1) STR 161
U2=R(I2) STR 162
U3=R(I3) STR 163
U4=R(I4) STR 164
U5=R(I5) STR 165
U6=R(I6) STR 166
V1=R(I1+1) STR 167
V2=R(I2+1) STR 168
V3=R(I3+1) STR 169
V4=R(I4+1) STR 170
V5=R(I5+1) STR 171
V6=R(I6+1) STR 172
C STR 173
CODE=0 STR 174
IF (KEL.GT.NT12.AND.KEL.LE.(NT12+NT1/2)) GO TO 60 STR 175
GO TO 65 STR 176
60 ETATWO=1.-ETA STR 177
ETAFOUR=1.-2.*ETA STR 178
ETA2=ETATWO*ETATWO STR 179
ETA4=ETAFOUR*ETAFOUR STR 180
CODE=1 STR 181
GO TO 70 STR 182
65 NT=IX(X,KEL) STR 183
ETAFOUR=1.0 STR 184
ETATWO=ETAFOUR STR 185
ETA4=1.0 STR 186
ETA2=ETA4 STR 187
C STR 188
C GENERATE AND STORE STRESS AND STRAINS ELEMENT BY ELEMENTC STR 189
C STR 190
70 K=KEL STR 191
F1=(4.*ZAI(1)-ETATWO)/ETATWO STR 192
F2=(4.*ZAI(2)-1.)/ETAFOUR STR 193
F3=4.*ZAI(3)-ETAFOUR STR 194
C STR 195
C STRAINS AT CENTROID STR 196
C STR 197
STRAINX=Y23*F1*U1+Y31*F2*U2+Y12*F3*U3+(Y23*4.*ZAI(2)+Y31*4.*ZAI(1))*U4/ETA2+(Y31*4.*ZAI(3)+Y12*4.*ZAI(2))*U5/ETAFOUR+(Y23*4.*ZSTR 198
1 (1))*U4/ETA2+(Y31*4.*ZAI(3)+Y12*4.*ZAI(2))*U5/ETAFOUR+(Y23*4.*ZSTR 199
2 AI(3)+Y12*4.*ZAI(1))*U6/ETAFOUR STR 200
STRAINX=0.5*STRAINX/AA STR 201
STRAINX=X32*F1*V1+X13*F2*V2+X21*F3*V3+4.*(X32*ZAI(2)+X13*ZAI(1))*V4/ETA2+4.*(X13*ZAI(3)+X21*ZAI(2))*V5/ETAFOUR+4.*(X32*ZAI(3)+STR 202
1 )*V4/ETA2+4.*(X13*ZAI(3)+X21*ZAI(2))*V5/ETAFOUR+4.*(X32*ZAI(3)+STR 203
2 X21*ZAI(1))*V6/ETAFOUR STR 204
STRAINX=0.5*STRAINX/AA STR 205
C STR 206
A1=X32*F1*U1 STR 207
A2=X13*F2*U2 STR 208
A3=X21*F3*U3 STR 209
A4=4.*(X32*ZAI(2)+X13*ZAI(1))*U4/ETA2 STR 210
A5=4.*(X13*ZAI(3)+X21*ZAI(2))*U5/ETAFOUR STR 211

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A6=4.*(Y23*ZAI(3)+Y21*ZAI(1))*U6/ETAFOUR      STR 212
B1=Y23*F1*V1                                   STR 213
B2=Y31*F2*V2                                   STR 214
B3=Y12*F3*V3                                   STR 215
B4=4.*(Y23*ZAI(2)+Y31*ZAI(1))*V4/ETA2         STR 216
B5=4.*(Y31*ZAI(3)+Y12*ZAI(2))*V5/ETAFOUR      STR 217
B6=4.*(Y23*ZAI(3)+Y12*ZAI(1))*V6/ETAFOUR      STR 218
STRANKY=A1+A2+A3+A4+A5+A6+B1+B2+B3+B4+B5+B6    STR 219
STRANKY=0.5*STRANKY/AF                         STR 220
C                                                STR 221
C                                                STR 222
C      ELEMENT STRESSES AT CENTROID IN X Y AND XY DIRECTIONS STR 223
C                                                STR 224
C      STRESSX=D11*STRAINX+D12*STRAINY+D13*STRANKY STR 225
C      STRESSY=D21*STRAINX+D22*STRAINY+D23*STRANKY STR 226
C      STRESXY=D31*STRAINX+D32*STRAINY+D33*STRANKY STR 227
C                                                STR 228
C      DETERMINE PRINCIPLE STRESSES SIGMA1, SIGMA2,SIGMA3 ... .. STR 229
C                                                STR 230
C      STRESS1=(STRESSX+STRESSY)/2.             STR 231
C      STRESS2=SQRT(((STRESSX-STRESSY)/2. )**2+STRESXY**2) STR 232
C      SIGMA1=STRESS1+STRESS2                   STR 233
C      SIGMA2=(STRESS1-STRESS2)                 STR 234
C      SIGMA2=(SIGMA1+SIGMA3)*(HUE1+HUE2)/2.    STR 235
C                                                STR 236
C      DETERMINE OCTAHEADRAL STRESSES SGMAOCT, TAUOCT ... .. STR 237
C                                                STR 238
C      SGMAOCT=(SIGMA1+SIGMA2+SIGMA3)/3.        STR 239
C      TAUOCT=(SQRT((SIGMA1-SIGMA2)**2+(SIGMA2-SIGMA3)**2+(SIGMA3-SIGMA1)**2))/3. STR 240
1 A1)**2))/3.                                   STR 241
C                                                STR 242
C      DETERMINE PRINCIPLE STRAINS EPLISH1, EPLISH2, EPLISH3 ... .. STR 243
C                                                STR 244
C      E1=(STRAINX+STRAINY)/2.                  STR 245
C      E2=SQRT(((STRAINX-STRAINY)/2. )**2+STRAHXY**2) STR 246
C      EPLISH1=E1+E2                             STR 247
C      EPLISH3=E1-E2                             STR 248
C      EPLISH2=(EPLISH1+EPLISH3)*(HUE1+HUE2)/2. STR 249
C                                                STR 250
C      DETERMINE OCTAHEADRAL STRAINS -- EPSMOCT, GAMAOCT ... .. STR 251
C                                                STR 252
C      EPSMOCT=(EPLISH1+EPLISH2+EPLISH3)/3.     STR 253
C      GAMAOCT=2.*(SQRT((EPLISH1-EPLISH2)**2+(EPLISH2-EPLISH3)**2+(EPLISH3-EPLISH1)**2))/3. STR 254
1 ISH3-EPLISH1)**2))/3.                       STR 255
C                                                STR 256
C      STORE STRESSES AND STRAINS ON TAPE 1      STR 257
C                                                STR 258
C      CALL READMS (1,TEMP,17,KEL)              STR 259
C      DELSIG1=SIGMA1                           STR 260
C      SIG1=TEMP(4)                              STR 261
C      STRESSX=STRESSX+TEMP(1)                   STR 262
C      STRESSY=STRESSY+TEMP(2)                   STR 263
C      STRESXY=STRESXY+TEMP(3)                   STR 264
C      SIGMA1=SIGMA1+TEMP(4)                     STR 265
C      SIGMA2=SIGMA2+TEMP(5)                     STR 266
C      SIGMA3=SIGMA3+TEMP(6)                     STR 267
C      SGMAOCT=SGMAOCT+TEMP(7)                   STR 268
C      TAUOCT=TAUOCT+TEMP(8)                     STR 269
C      STRAINX=STRAINX+TEMP(9)                   STR 270
C      STRAINY=STRAINY+TEMP(10)                  STR 271

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	STRANKY=STRANKY+TEMP(11)	STR	272
	EPLISH1=EPLISH2+TEMP(12)	STR	273
	EPLISH2=EPLISH2+TEMP(13)	STR	274
	EPLISH3=EPLISH3+TEMP(14)	STR	275
	EPSHDOCT=EPSHDOCT+TEMP(15)	STR	276
	GAMADCT=GAMADCT+TEMP(16)	STR	277
C		STR	278
	TEMP(1)=STRESSX	STR	279
	TEMP(2)=STRESSY	STR	280
	TEMP(3)=STRESSXY	STR	281
	TEMP(4)=SIGMA1	STR	282
	TEMP(5)=SIGMA2	STR	283
	TEMP(6)=SIGMA3	STR	284
	TEMP(7)=GAMADCT	STR	285
	TEMP(8)=TAUOCT	STR	286
	TEMP(9)=STRAINX	STR	287
	TEMP(10)=STRAINXY	STR	288
	TEMP(11)=STRANKY	STR	289
	TEMP(12)=EPLISH1	STR	290
	TEMP(13)=EPLISH2	STR	291
	TEMP(14)=EPLISH3	STR	292
	TEMP(15)=EPSHDOCT	STR	293
	TEMP(16)=GAMADCT	STR	294
C		STR	295
	CALL WRITMS (1,TEMP,17,KEL)	STR	296
C		STR	297
	IF (NOTENSH,LE,0) GO TO 100	STR	298
C		STR	299
C	NO-TENSION ANALYSIS	STR	300
C		STR	301
	SIGTOTL=SIG1+DELSIG1	STR	302
	IF (SIGTOTL+GAMMA(MT)) 75,100,100	STR	303
75	WRITE (6,165) KEL,SIG1,DELSIG1	STR	304
	CALL ZERO (PP,12)	STR	305
	CALL HULLMAT (SKUT,12,12)	STR	306
	RATIO=1.-ABS(SIG1)/ABS(DELSIG1)	STR	307
	ND=11	STR	308
	DO 85 IM=1,12	STR	309
	DO 80 JM=IM,12	STR	310
	ND=ND+1	STR	311
80	SKUT(JM,JM)=SKUT(JM,IM)+RATIO*AT(ND)	STR	312
85	CONTINUE	STR	313
	U(1)=U1	STR	314
	U(2)=U2	STR	315
	U(3)=U3	STR	316
	U(4)=U4	STR	317
	U(5)=U5	STR	318
	U(6)=U6	STR	319
	U(7)=V1	STR	320
	U(8)=V2	STR	321
	U(9)=V3	STR	322
	U(10)=V4	STR	323
	U(11)=V5	STR	324
	U(12)=V6	STR	325
	DO 95 JI=1,12	STR	326
	SUM=0.0	STR	327
	DO 90 KI=1,12	STR	328
90	SUM=SUM+SKUT(JI,KI)*U(KI)	STR	329
	PPC(JI)=-SUM/RATIO	STR	330
95	CONTINUE	STR	331



C	Q(I1)=Q(I1)+PP(1)	STR 332
	Q(I2)=Q(I2)+PP(2)	STR 333
	Q(I3)=Q(I3)+PP(3)	STR 334
	Q(I4)=Q(I4)+PP(4)	STR 335
	Q(I5)=Q(I5)+PP(5)	STR 336
	Q(I6)=Q(I6)+PP(6)	STR 337
	Q(I1+1)=Q(I1+1)+PP(7)	STR 338
	Q(I2+1)=Q(I2+1)+PP(8)	STR 339
	Q(I3+1)=Q(I3+1)+PP(9)	STR 340
	Q(I4+1)=Q(I4+1)+PP(10)	STR 341
	Q(I5+1)=Q(I5+1)+PP(11)	STR 342
	Q(I6+1)=Q(I6+1)+PP(12)	STR 343
	IFLAG=1	STR 344
		STR 345
C		STR 346
100	CONTINUE	STR 347
	IF (NT3.LE.0) GO TO 160	STR 348
	IF (INTER.LE.0) GO TO 160	STR 349
		STR 350
C		STR 351
C	HO-TENSION ANALYSIS FOR INTERACTION ELEMENT	STR 352
C		STR 353
	NSTART=NT1+1	STR 354
	DO 155 KEL=NSTART,NT12/2	STR 355
	MT=IX(8,KEL)	STR 356
	FR(2)=0.0	STR 357
	FR(1)=FR(2)	STR 358
	CALL READMS (1,TEMP,17,KEL)	STR 359
	CALL READMS (1,TEMP,17,KEL+1)	STR 360
	PNDRML=(TEMP(1)+TEMP(2))*0.5	STR 361
	PSHEAR=(TEMP(2)+TEMP(3))*0.5	STR 362
	IF (ABS(PNDRML).LT.GAMMA(NT)) GO TO 155	STR 363
	IF (PNDRML+GAMMA(NT)) 110,105,105	STR 364
105	IF (NCYCLE.EQ.1) GO TO 155	STR 365
	RATIO=ABS(PSHEAR/PNDRML)	STR 366
	IF (RATIO.LE.SLIP) GO TO 155	STR 367
	R1=ABS(TEMP(15)/TEMP(16))	STR 368
	Q0=TEMP(13)/TEMP(14)	STR 369
	FIXH=TEMP(16)	STR 370
	PH=TEMP(14)	STR 371
	DR=SLIP-R1	STR 372
	T3=Q0-R1-DR	STR 373
	DSR=DR*FIXH/T3	STR 374
	T4=(PH-DSR)/PH	STR 375
	FR(1)=T4+FR(1)	STR 376
	FR(1)=-FR(1)	STR 377
	WRITE (6,170) KEL,RATIO,SLIP,R1,Q0,DR,DSR,FIXH,PH,FR(1)	STR 378
	R1=ABS(TEMP(15)/TEMP(16))	STR 379
	Q0=TEMP(13)/TEMP(14)	STR 380
	FIXH=TEMP(16)	STR 381
	PH=TEMP(14)	STR 382
	DR=SLIP-R1	STR 383
	T3=Q0-R1-DR	STR 384
	DSR=DR*FIXH/T3	STR 385
	T4=(PH-DSR)/PH	STR 386
	FR(2)=T4+FR(2)	STR 387
	FR(2)=-FR(2)	STR 388
	KEL1=KEL+1	STR 389
	WRITE (6,170) KEL1,RATIO,SLIP,R1,Q0,DR,DSR,FIXH,PH,FR(2)	STR 390
	GO TO 115	STR 391
C		





110	T1=(TEMP(16)+TEMP(16))/2.	STR	392
	T2=(TEMP(14)+TEMP(14))/2.	STR	393
C		STR	394
C	FR(1)=FR(2)=1.-ABS(T1)/ABS(T2)	STR	395
C		STR	396
	T3=1.-T1/2	STR	397
	FR(2)=T3/2.	STR	398
	FR(1)=FR(2)	STR	399
	KEL1=KEL+1	STR	400
	WRITE (6,175) KEL,KEL1,FR(1),FR(2)	STR	401
115	NUM=KEL	STR	402
	ND=1	STR	403
120	CALL READMS (7,DHAT,6*,NUM)	STR	404
	MD=0	STR	405
	DO 125 IM=1,8	STR	406
	DO 125 JM=1,8	STR	407
	MD=MD+1	STR	408
	SKJT(IM,JM)=DHAT(MD)	STR	409
125	CONTINUE	STR	410
	DO 140 IM=1,8	STR	411
	GO TO (130,135), ND	STR	412
130	U(IM)=TEMP(IM+4)	STR	413
	GO TO 140	STR	414
135	U(IM)=TEMP(IM+4)	STR	415
140	CONTINUE	STR	416
	DO 150 JI=1,8	STR	417
	SUM=0.0	STR	418
	DO 145 KI=1,8	STR	419
145	SUM=SUM+SKJT(JI,KI)*U(KI)	STR	420
C		STR	421
C	PP(JI)=-SUM * FR(ND)	STR	422
C		STR	423
	PP(JI)=SUM*FR(ND)	STR	424
150	CONTINUE	STR	425
	WRITE (6,180) (PP(JI),JI=1,8)	STR	426
	I1=IA(NUM,1)	STR	427
	I2=IA(NUM,2)	STR	428
	I3=IA(NUM,3)	STR	429
	I4=IA(NUM,4)	STR	430
C		STR	431
	Q(I1)=Q(I1)+PP(1)	STR	432
	Q(I1+1)=Q(I1+1)+PP(2)	STR	433
	Q(I2)=Q(I2)+PP(3)	STR	434
	Q(I2+1)=Q(I2+1)+PP(4)	STR	435
	Q(I3)=Q(I3)+PP(5)	STR	436
	Q(I3+1)=Q(I3+1)+PP(6)	STR	437
	Q(I4)=Q(I4)+PP(7)	STR	438
	Q(I4+1)=Q(I4+1)+PP(8)	STR	439
	IFLAG=1	STR	440
	ND=ND+1	STR	441
	IF (ND,GT,2) GO TO 155	STR	442
	NUM=KEL+1	STR	443
	GO TO 120	STR	444
155	CONTINUE	STR	445
160	WRITE (6,185)	STR	446
	RETURN	STR	447
C		STR	448
165	FORMAT (10X, 24HTENSION IN ELEMENT ND = ,I5, 8H SIGMA1=,E12.3, 13STR		449
	1H DELSIGMA1 = ,E12.3)	STR	450
170	FORMAT (1X, 8HINT SLIP,T5,9E12.3)	STR	451



175	FORMAT (1X) 20HINTERACTION TENSION,215,2E12.3)	STR	452
180	FORMAT (1X) 9HINT.FORCE 8E12.3)	STR	453
185	FORMAT (1X) 20HOVERLAY (4,0) COMPLETED)	STR	454
C		STR	455
	END	STR	456
	OVERLAY(CROY,5,0)	RES	1
C	OVERLAY(CROY,5,0)	RES	2
	PROGRAM RESULTS	RES	3
	COMMON /NODE3/ NLELENT,NDOF,MBAND,ND,NT3,ISTOP,NCYCLE,LAYERS,ISTEP,RES	RES	4
	1NSTEP,NT12,ETA,HT1,HT2,NUTENSH,IFLAG,NSIZE,NCODE(550),X(550),Y(550)RES	RES	5
	2),JNDX(S1),ANLSIS,IX(8,250),ARFPAK(250),INDX(250),INDEX(250),GAMA(2RES	RES	6
	35),ZAI(3)	RES	7
	COMMON /1/ E,HUE,RADIUS,DOEN,YLEN,EI,KN,KS,H1,H2,INTER	RES	8
	COMMON /3/ R	RES	9
	DIMENSION TENP(17), R(1100), RP(1100)	RES	10
	DIMENSION E(10), HUE(10)	RES	11
	DIMENSION TRP(36), U(6), SRG(6,6), PWY(30), QCY(30), MOM(30), P(30)RES	RES	12
	I), Q(30), PP(6)	RES	13
	DIMENSION SG(30), S1(90)	RES	14
	REAL HUE	RES	15
	REAL KN,KS	RES	16
	REAL MOM	RES	17
	INTEGER U1,U2,U3,U4,U5,U6,U7,U8,U9	RES	18
C		RES	19
C	THIS ROUTINE RECORDS RESULTS FROM DIFFERENT ROUTINES AND TAPES ANDRES	RES	20
C	STORES, ADDS, FOR SUCCESSIVE TERMS IF INCREMENTAL ANALYSIS AND	RES	21
C	FINALLY OUTPUTTED	RES	22
C		RES	23
C	WRITTING NODAL FORCES, DISPLACEMENTS, ELEMENT STRESSES, STRAINS ..	RES	24
C		RES	25
	REWIND 2	RES	26
	NDRING=3*NT3	RES	27
	DO 5 I=1,NDRING	RES	28
5	S1(I)=R(I)	RES	29
	READ (2) (R(I),I=1,NDOF)	RES	30
	DO 10 I=1,NDOF	RES	31
	R(I)=R(I)+R(I)	RES	32
10	CONTINUE	RES	33
	REWIND 2	RES	34
	WRITE (2) (R(I),I=1,NDOF)	RES	35
C		RES	36
	WRITE (6,90) ISTEP,NCYCLE	RES	37
	IF (NT3.LE.0) GO TO 20	RES	38
	WRITE (6,95)	RES	39
	DO 15 I=1,NT3	RES	40
	K1=3*I-2	RES	41
	WRITE (6,100) I,R(K1),R(K1+1),R(K1+2)	RES	42
15	CONTINUE	RES	43
20	IF (NCYCLE.NE.NSTEP) GO TO 35	RES	44
	IF (IFLAG.GT.0) GO TO 35	RES	45
	WRITE (6,105)	RES	46
	NT3P1=NT3+1	RES	47
	DO 25 I=NT3P1/(NMODES,3	RES	48
	K1=2*I-1+NT3	RES	49
	K2=K1+1	RES	50
	K3=2*(I+1)-1+NT3	RES	51
	K4=K3+1	RES	52
	K5=2*(I+2)-1+NT3	RES	53
	K6=K5+1	RES	54
	I2=I+2	RES	56



	WRITE (6,110) I,R(K1),R(K2),I1,R(K3),R(K4),I2,R(K5),R(K6)	RES	57
25	CONTINUE	RES	58
C		RES	59
C	PRINT ELEMENT STRESSES	RES	60
C		RES	61
	WRITE (6,115)	RES	62
	NT12P1=NT12+1	RES	63
	DO 30 I=NT12P1,NELEMT	RES	64
	CALL READMS (1,TEMP,17,I)	RES	65
	WRITE (6,120) (I,(TEMP(J),J=1,8))	RES	66
30	CONTINUE	RES	67
C		RES	68
C	CALCULATION OF NORMAL, SHEAR FORCE AND MOMENTS FOR PIPE NODES	RES	69
C		RES	70
35	IF (NT3.LE.0) GO TO 85	RES	71
	WRITE (6,125)	RES	72
	NEL=NT3-1	RES	73
	DO 55 I=1,NEL	RES	74
	IF (IX(7,I).NE.1) GO TO 55	RES	75
	I1=IX(1,I)	RES	76
	I2=IX(2,I)	RES	77
	U1=3*(I1-1)+1	RES	78
	U2=U1+1	RES	79
	U3=U1+2	RES	80
	U4=3*(I2-1)+1	RES	81
	U5=U4+1	RES	82
	U6=U4+2	RES	83
	U(1)=S1(U1)	RES	84
	U(2)=S1(U2)	RES	85
	U(3)=S1(U3)	RES	86
	U(4)=S1(U4)	RES	87
	U(5)=S1(U5)	RES	88
	U(6)=S1(U6)	RES	89
	CALL READMS (7,TMP,36,I)	RES	90
C		RES	91
	ND=0	RES	92
	CALL READMS (1,TEMP,17,I)	RES	93
	DO 40 K=1,6	RES	94
	DO 40 L=1,6	RES	95
	ND=ND+1	RES	96
	SRG(K,L)=TMP(ND)	RES	97
40	CONTINUE	RES	98
	DO 50 K=1,6	RES	99
	SUM=0.0	RES	100
	DO 45 L=1,6	RES	101
45	SUM=SUM+SRG(K,L)*U(L)	RES	102
	PP(K)=SUM	RES	103
50	CONTINUE	RES	104
	PXY(11)=PP(4)+TEMP(3)	RES	105
	QXY(11)=PP(5)+TEMP(4)	RES	106
	MDM(11)=PP(6)+TEMP(5)	RES	107
	PXY(12)=PP(1)+TEMP(6)	RES	108
	QXY(12)=PP(2)+TEMP(7)	RES	109
	MDM(12)=PP(3)+TEMP(8)	RES	110
	TEMP(3)=PXY(11)	RES	111
	TEMP(4)=QXY(11)	RES	112
	TEMP(5)=MDM(11)	RES	113
	TEMP(6)=PXY(12)	RES	114
	TEMP(7)=QXY(12)	RES	115
	TEMP(8)=MDM(12)	RES	116



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      CALL WRITMS (1,TEMP,17,I)                                RES 117
55 CONTINUE                                                    RES 118
      DO 70 I=1,NT3                                           RES 119
        IF (1.E0,NT3) GO TO 60                                RES 120
        GO TO 65                                              RES 121
60      PXY(I)=-PXY(I)                                         RES 122
        QXY(I)=-QXY(I)                                         RES 123
        MOM(I)=-MOM(I)                                         RES 124
65      YC=Y(I)-YCEH                                           RES 125
        XC=X(I)-XCEH                                           RES 126
        IF (XC,E0,0.0) XC=0.00001                             RES 127
        TH=YC/XC                                               RES 128
        THETA=ATAN(TN)                                          RES 129
        SH=SIN(THETA)                                          RES 130
        CS=COS(THETA)                                          RES 131
        P(I)=-PXY(I)*SH+QXY(I)*CS                             RES 132
        Q(I)=-PXY(I)*CS+QXY(I)*SH                             RES 133
        WRITE (6,130) I,P(I),Q(I),MOM(I)                     RES 134
70 CONTINUE                                                    RES 135
        WRITE (6,140)                                           RES 136
        NSTART=NT1+1                                           RES 137
        DO 75 I=NSTART,NT12,2                                   RES 138
          CALL READMS (1,TEMP,17,I)                             RES 139
          T1=TEMP(1)                                           RES 140
          T2=TEMP(2)                                           RES 141
          CALL READMS (1,TEMP,17,I+1)                           RES 142
          TEMP(1)=0.5*(T1+TEMP(1))                             RES 143
          TEMP(2)=0.5*(T2+TEMP(2))                             RES 144
          RATIO=ABS(TEMP(2)/TEMP(1))                             RES 145
          IF1=I+1                                               RES 146
          WRITE (6,135) I,IP1,TEMP(1),TEMP(2),RATIO           RES 147
75 CONTINUE                                                    RES 148
C                                                                    RES 149
C                                                                    RES 150
C                                                                    RES 151
        WRITE (6,145)                                           RES 152
        DO 80 I=NT12P1,NELEMT                                     RES 153
          CALL READMS (1,TEMP,17,I)                             RES 154
          WRITE (6,120) (I,(TEMP(J),J=9,16))                   RES 155
80 CONTINUE                                                    RES 156
85 WRITE (6,150)                                               RES 157
        RETURN                                                  RES 158
C                                                                    RES 159
90 FORMAT (1H1,10X, 14HRESULTS AFTER ,I5, 17H LAYERS OF FILL,5X, 15RES 160
1HINCREMENT NO = ,I5//)                                       RES 161
95 FORMAT (10X, 28H3 - D.O.F. NODAL DEFLECTIONS//10X, 8HNODE NO.,5XRES 162
1, 14HX - DEFLECTION,5X, 14HY - DEFLECTION,5X, 8HROTATION,/)   RES 163
100 FORMAT (7X,15,7X,3(E14,4,5X))                             RES 164
105 FORMAT (/10X, 21HNODE POINT DEFLECTION,//3(3X, 8HNODE NO.,3X, 12RES 165
1HX-DEFLECTION,3X, 12HY-DEFLECTION,3X)                         RES 166
110 FORMAT (3(5X,14,5X,E12,4, 3X,E12,4))                       RES 167
115 FORMAT (1H1,10X, 16HELEMENT STRESSES,//5X, 11HELEMENT NO.,3X, 7HSRES 168
1TRESSX,7X, 7HSTRESSY,7X, 7HSTRESSXY,7X, 6HSIGMA1,8X, 6HSIGMA2,8RES 169
2X, 6HSIGMA3,7X, 8HSIGMACT,6X, 7HTAUQCTA,/)                   RES 170
120 FORMAT (5X,15,2X,E14,2)                                     RES 171
125 FORMAT (/10X, 47HNORMAL AND SHEAR FORCES, MOMENTS AT PIPE NODES,RES 172
1/10X, 8HNODE NO.,10X, 12HNORMAL FORCE,5X, 11HSHEAR FORCE,5X, 12HNRES 173
2ODAL MOMENT,/)                                               RES 174
130 FORMAT (13X,13,12X,E12,2,2(4X,E12,2))                     RES 175
135 FORMAT (3X,12, 3H + ,12,12X,E10,2,12X,E10,2,12X,F10,4)   RES 176

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140 FORMAT (////10%, 52HNORMAL AND SHEAR STRESS ON SOIL IN INTERACTION RES 177
1LAYER,////5%, 7HELE.ND.,10%, 12HNORMAL STRS.,10%, 12HSHEAR STRESS,1RES 178
20%, 12H RATIO T/H ,//) RES 179
145 FORMAT (1H1/10%, 1SELEMENT STRAINS,//5%, 11HELEMENT NO.,3%, 7HSTRES 180
1RAINX,7%, 7HSTRAINY,7%, 7HSTRAINX,7%, 7HEPSILN1,7%, 7HEPSILN2,RES 181
27%, 7HEPSILN3,7%, 7HEP.NDCT,7%, 7HGAMADCT,/) RES 182
150 FORMAT (1X, 23HOVERLAY (%.0) COMPLETED) RES 183
C RES 184
END RES 185
OVERLAY(RDY,6,0) SOL 1
C OVERLAY(RDY,6,0) SOL 2
PROGRAM RESOLV SOL 3
COMMON NNODES,NELEMNT,NDOF,NEARR,ND,NT3,ISTDP,NCYCLE,LAYERS,ISTEP,SOL 4
1HSTEP,NT12,ETR,NT1,NT2,NOTENSN, FLAG,NSIZE,MCODE(550),X(550),Y(550)SOL 5
2),JNDX(51),ARLX13,IX(8,250),AREAA(250),INDX(250),INDEX(250),GAMA(2SOL 6
35),ZAI(3) SOL 7
COMMON /3/ P SOL 8
COMMON /5/ Q(1100),LIST(101) SOL 9
DIMENSION A(103*206), B(206), PPRAY(103) SOL 10
DIMENSION R(1100) SOL 11
PERIND 9 SOL 12
C SOL 13
C SOLUTION OF STIFFNESS EQUATIONS FOR GIVEN BOUNDARY CONDITIONS AND SOL 14
C SOL 15
HUNDLK=1 SOL 16
HL=1 SOL 17
HM=ND SOL 18
KSHIFT=0 SOL 19
ND2=2*ND SOL 20
NEND=3*NT3 SOL 21
NDINC=1 SOL 22
IF (NT3.LE.0) NDINC=0 SOL 23
IF (NT3.LE.0) ND=ND+1 SOL 24
CALL NULLHAT (A,ND,ND2) SOL 25
CALL ZERO (B,ND2) SOL 26
NX=HL-1 SOL 27
CALL ZERO (ARRAY,NSIZE) SOL 28
DO 10 N=1,NSIZE SOL 29
CALL READHS (10*ARRAY,NSIZE,(NX+N) SOL 30
DO 5 M=1,NSIZE SOL 31
A(N,M)=ARRAY(M) SOL 32
10 CONTINUE SOL 33
GO TO 30 SOL 34
15 NX=HL-1 SOL 35
CALL ZERO (ARRAY,NSIZE) SOL 36
DO 25 N=1,NSIZE SOL 37
CALL READHS (10*ARRAY,NSIZE,(NX+N) SOL 38
DO 20 M=1,NSIZE SOL 39
A(N,M)=A(N,M)+ARRAY(M) SOL 40
25 CONTINUE SOL 41
C SOL 42
C MODIFICATION FOR LOAD AND BOUNDARY CONDITIONS SOL 43
C SOL 44
30 I=HL SOL 45
35 IF (I.GT.NEND) GO TO 70 SOL 46
FIND=FLOAT(I+2)/3. SOL 47
II=INT(FIND) SOL 48
PX=Q(I) SOL 49
PY=Q(I+1) SOL 50
ICODE=ICODE(I)-3 SOL 51

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	GO TO (40,45,50,55,60,65), ICODE	SOL	52
40	J=I-KSHIFT	SOL	53
	B(J)=B(J)+PX	SOL	54
	B(J+1)=B(J+1)+PY	SOL	55
	I=I+3	SOL	56
	GO TO 35	SOL	57
45	J=I-KSHIFT	SOL	58
	P=0.0	SOL	59
	CALL MODIFY (J,ND,P,A,B)	SOL	60
	B(J+1)=B(J+1)+PY	SOL	61
	I=I+3	SOL	62
	GO TO 35	SOL	63
50	J=I-KSHIFT	SOL	64
	B(J)=B(J)+PX	SOL	65
	P=0.0	SOL	66
	CALL MODIFY (J+1,ND,P,A,B)	SOL	67
	I=I+3	SOL	68
	GO TO 35	SOL	69
55	J=I-KSHIFT	SOL	70
	B(J)=B(J)+PX	SOL	71
	B(J+1)=B(J+1)+PY	SOL	72
	P=0.0	SOL	73
	CALL MODIFY (J+2,ND,P,A,B)	SOL	74
	I=I+3	SOL	75
	GO TO 35	SOL	76
60	J=I-KSHIFT	SOL	77
	P=0.0	SOL	78
	CALL MODIFY (J,ND,P,A,B)	SOL	79
	B(J+1)=B(J+1)+PY	SOL	80
	CALL MODIFY (J+2,ND,P,A,B)	SOL	81
	I=I+3	SOL	82
	GO TO 35	SOL	83
65	J=I-KSHIFT	SOL	84
	B(J)=B(J)+PX	SOL	85
	P=0.0	SOL	86
	CALL MODIFY (J+1,ND,P,A,B)	SOL	87
	CALL MODIFY (J+2,ND,P,A,B)	SOL	88
	I=I+3	SOL	89
	GO TO 35	SOL	90
70	IF (I.GT.NM.OR.I.GT.NDOF) GO TO 95	SOL	91
	FIND=FLOAT(I-INT3+1)/2.	SOL	92
	II=INT(FIND)	SOL	93
	PX=0(I)	SOL	94
	PY=0(I+1)	SOL	95
	ICODE=NCODE(II)+1	SOL	96
	GO TO (75,80,85,90), ICODE	SOL	97
75	J=I-KSHIFT	SOL	98
	B(J)=B(J)+PX	SOL	99
	B(J+1)=B(J+1)+PY	SOL	100
	I=I+2	SOL	101
	GO TO 70	SOL	102
80	J=I-KSHIFT	SOL	103
	P=0.0	SOL	104
	CALL MODIFY (J,ND,P,A,B)	SOL	105
	B(J+1)=B(J+1)+PY	SOL	106
	I=I+2	SOL	107
	GO TO 70	SOL	108
85	J=I-KSHIFT	SOL	109
	B(J)=B(J)+PX	SOL	110
	P=0.0	SOL	111



CALL MODIFY (J+1,ND,P,A,E)	SOL	112
I=I+2	SOL	113
GO TO 70	SOL	114
90 J=I-KSHIFT	SOL	115
P=0.0	SOL	116
CALL MODIFY (J,ND,P,A,B)	SOL	117
CALL MODIFY (J+1,ND,P,A,E)	SOL	118
I=I+2	SOL	119
GO TO 70	SOL	120
95 CONTINUE	SOL	121
C	SOL	122
C	SOL	123
C	SOL	124
DO 110 N=1,ND	SOL	125
IF (A(1,N).EQ.0.0) GO TO 119	SOL	126
B(N)=B(N)/A(1,N)	SOL	127
DO 105 L=2,MBAND	SOL	128
IF (A(L,N).EQ.0.0) GO TO 105	SOL	129
CX=A(L,N)/A(1,N)	SOL	130
I=N+L-1	SOL	131
J=0	SOL	132
DO 100 E=L,MBAND	SOL	133
J=J+1	SOL	134
100 A(J,I)=A(J,I)-CX*A(K,N)	SOL	135
B(I)=B(I)-A(L,N)*B(N)	SOL	136
A(L,N)=CX	SOL	137
105 CONTINUE	SOL	138
110 CONTINUE	SOL	139
IF (NMLGE.NBDF) GO TO 124	SOL	140
C	SOL	141
C	SOL	142
C	SOL	143
WRITE (9) (B(N),(A(M,N)/A(1,NBAND)),N=1,ND)	SOL	144
C	SOL	145
C	SOL	146
C	SOL	147
DO 115 N=1,ND	SOL	148
MM=ND+N	SOL	149
B(M)=B(M)	SOL	150
B(MM)=0.0	SOL	151
DO 115 M=1,MBAND	SOL	152
A(M,N)=A(M,MM)	SOL	153
A(M,MM)=0.0	SOL	154
115 CONTINUE	SOL	155
KSHIFT=KSHIFT+ND	SOL	156
IF (NUMBERL.EQ.1) ND=ND-M*INC	SOL	157
NUMBERL=NUMBERL+1	SOL	158
MM=MM+ND	SOL	159
ML=MM-ND+1	SOL	160
GO TO 15	SOL	161
C	SOL	162
C	SOL	163
C	SOL	164
120 CALL ZERO (R,NBDF)	SOL	165
IF (NUMBERL.EQ.1) NBINC=0	SOL	166
C	SOL	167
ND=ND*NUMBERL+1+NBINC	SOL	168
NE=NUMBERL	SOL	169
125 DO 135 M=1,ND	SOL	170
N=ND+1-M	SOL	171



	DO 100 K=2,MBAND	SOL	172
	L=N+K-1	SOL	173
130	B(L)=B(L)-A(L)*R)*B(L)	SOL	174
	NM=N+ND	SOL	175
	IF (N.EQ.2) NM=NM+ND*NC	SOL	176
	B(NM)=B(L)	SOL	177
	NU=NU-1	SOL	178
135	P(NU)=B(NU)	SOL	179
	NB=NB-1	SOL	180
	IF (N.EQ.1) ND=ND+ND*NC	SOL	181
	IF (N.EQ.0) GO TO 140	SOL	182
	BACKSPACE 9	SOL	183
	READ (9) (B(ND),C(ND),N),N=1,NB*ND	SOL	184
	BACKSPACE 9	SOL	185
	GO TO 135	SOL	186
140	CONTINUE	SOL	187
	RETURN	SOL	188
C		SOL	189
C		SOL	190
	END	SOL	191
	SUBROUTINE MURPHY (N,ND,P,A,B)		2
	DIMENSION A(100,200), B(100)		3
C			4
C	MODIFICATION FOR BOUNDARY CONDITIONS		5
C			6
	ND2=2*ND		7
	DO 10 M=2,ND		8
	K=M-M+1		9
	IF (K.EQ.0) GO TO 5		10
	B(K)=B(K)-A(M,K)*P		11
	A(M,K)=0.0		12
5	K=M-M-1		13
	IF (K.GT.ND2) GO TO 10		14
	B(K)=B(K)-A(M,K)*P		15
	A(M,K)=0.0		16
10	CONTINUE		17
	A(1,N)=0.0		18
	B(N)=0.0		19
	RETURN		20
C			21
	END		22





APPENDIX - II

PROPERTY  
PROGRAM LISTING



	PROGRAM PROPERTY (INPUT,OUTPUT)	PRO	2
	DIMENSION XP(20), YP(20), VP(20), YDP1(20), YDPV(20), TITL(10)	PRO	3
	REAL NUE,NUEIN	PRO	4
	DATA PLSTRS,PLSTRN/6HPLSTRS,6HPLSTRN/	PRO	5
C		PRO	6
C	THIS PROGRAM GENERATES DATA REQUIRED FOR EVALUATION OF TANGENT	PRO	7
C	MODULUS AND POISSONS RATIO VS. SIGMA(OCT) FOR VARIOUS STRESS RATIO	PRO	8
C		PRO	9
	READ 70, (TITL(I),I=1,10)	PRO	10
	READ 75, TEST,NDCURVS,RF	PRO	11
	IF (TEST.EQ.PLSTRS) NGO=1	PRO	12
	IF (TEST.EQ.PLSTRN) NGO=2	PRO	13
	DO 65 IX=1,NDCURVS	PRO	14
	READ 80, SIGMA3,NP	PRO	15
	READ 85, (XP(I),YP(I),VP(I),I=1,NP)	PRO	16
	PRINT 70, (TITL(I),I=1,10)	PRO	17
	PRINT 90, IX,SIGMA3,NP,RF	PRO	18
	PRINT 95, (I,XP(I),YP(I),VP(I),I=1,NP)	PRO	19
	DO 5 I=1,NP	PRO	20
5	VP(I)=VP(I)-XP(I)	PRO	21
	S1IN=SIGMA3	PRO	22
	XIN=0.0	PRO	23
	E3IN=0.0	PRO	24
	CALL SPLINE (NP,XP,YP,YDP1)	PRO	25
	CALL SPLINE (NP,XP,VP,YDPV)	PRO	26
	PRINT 100	PRO	27
	X=0.00001	PRO	28
	DX=0.000001	PRO	29
	NUE=0.5	PRO	30
10	DO 15 L=2,NP	PRO	31
	IF (X.LT.XP(L).AND.X.GE.XP(L-1)) GO TO 20	PRO	32
15	CONTINUE	PRO	33
	GO TO 65	PRO	34
20	A=YDP1(L-1)	PRO	35
	B=YDP1(L)	PRO	36
	C=XP(L-1)	PRO	37
	D=XP(L)	PRO	38
	E=YP(L-1)	PRO	39
	F=YP(L)	PRO	40
	PP=X	PRO	41
	S1=ORDINET(A,B,C,D,E,F,PP)	PRO	42
C		PRO	43
	DO 25 L=2,NP	PRO	44
	IF (X.LT.XP(L).AND.X.GE.XP(L-1)) GO TO 30	PRO	45
25	CONTINUE	PRO	46
	GO TO 65	PRO	47
30	A=YDPV(L-1)	PRO	48
	B=YDPV(L)	PRO	49
	C=XP(L-1)	PRO	50
	D=XP(L)	PRO	51
	E=VP(L-1)	PRO	52
	F=VP(L)	PRO	53
	PP=X	PRO	54
	E3=ORDINET(A,B,C,D,E,F,PP)	PRO	55
	B1=S1+SIGMA3	PRO	56
	B3=SIGMA3	PRO	57
	GO TO (35,40), NGO	PRO	58
35	B2=B3	PRO	59
	GO TO 45	PRO	60













	ET=T1+T2+T3+T4	ET	8
	RETURN	ET	9
C		ET	10
	END	ET	11
	FUNCTION FD(S1,S2,R1,R2,R3)	FD	2
	IF (S1-S2) 5,10,5	FD	3
5	FD=(R2-R1)/S1	FD	4
	RETURN	FD	5
10	FD=(-3.*R1+4.*R2-R3)/(2.*S1)	FD	6
	RETURN	FD	7
C		FD	8
	END	FD	9
	FUNCTION BD(S1,S2,R1,R2,R3)	BD	2
	IF (S1-S2) 5,10,5	BD	3
5	BD=(R3-R2)/S2	BD	4
	RETURN	BD	5
10	BD=(3.*R3-4.*R2+R1)/(2.*S1)	BD	6
	RETURN	BD	7
C		BD	8
	END	BD	9
	FUNCTION ORDINET(A,B,C,D,E,F,P)	ORD	2
	HJ=D-C	ORD	3
	B1=D-P	ORD	4
	B2=P-C	ORD	5
	A1=B1**3	ORD	6
	A2=B2**3	ORD	7
	T1=A1*A/(6.*HJ)	ORD	8
	T2=A2*B/(6.*HJ)	ORD	9
	T3=(E-A*HJ**2/6.)*(D-P)/HJ	ORD	10
	T4=(F-B*HJ**2/6.)*(P-C)/HJ	ORD	11
	ORDINET=T1+T2+T3+T4	ORD	12
	RETURN	ORD	13
C		ORD	14
	END	ORD	15





